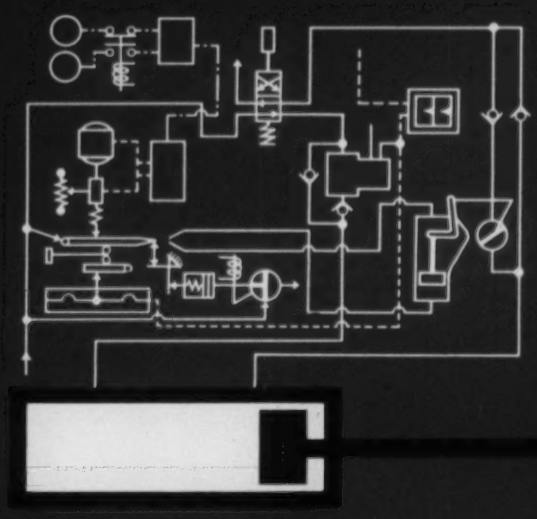
AUTOMATION

JULY 1958



FEEDBACK CONTROLLED

Steel Slab Cutoff

The Magazine of Automatic Operations

- Automatic Weighing Techniques
- Basic Electrical Controls
- Transferring Racks Automatically
- Versatile Transfer Machine

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A PENTON PUBLICATION

Seeking an answer to the squeeze on profits?

The economic outlook makes searching re-appraisal of production techniques a must these days. For in the ever-shrinking gap between selling price and cost lies the future and vitality of every business.

While the answer to cost reduction in any particular company is never simple, let's examine, for a moment, the relatively narrow problem of stamped parts production, a factor in many metalworking businesses. While the use of stampings, rather than machined or cast parts, means economy in itself, there is still a vast potential for savings in their production.

We at Wean have a unique product to sell for the production of stamped parts. It is called the "Flying Press," a name that has been adopted to describe the unusual motion of this press. We call it unique because the "Flying Press" produces stamped and formed metal parts at a rate (and low cost) hitherto unheard of in the industry: all due to its revolutionary design which eliminates clutch, brake and flywheel.

As you might presume, the "Flying Press" costs more initially than ordinary presses of the same tonnage. It costs more because it offers far greater production, versatility, and operating economies . . . and costs more to build. (We're in the same position you are, after all.) But even with this higher equipment cost to be amortized against production, the "Flying Press" produces stamped parts in the most economical way yet devised. Certainly, if you use stampings extensively in your production process, you should know more about this unusual piece of equipment.

We'd like to send you a brochure that describes the "Flying Press" and its advantages. Then, if you are interested in how it can apply to your specific production processes, we'll be glad to explore the matter further with you. We can even run your dies on a demonstration machine at our Cleveland plant. Please let us hear from you.

WEAN

WEAN EQUIPMENT CORPORATION

CLEVELAND 17, OHIO

Detroit • Chicago • Newark

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What! Painting or Etching to Suit the Occasion!

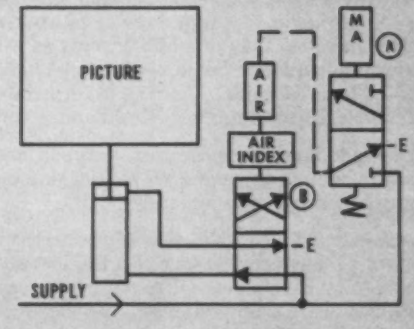
This "one knob picture control" is unlikely we will agree, but . . .

Art tastes do vary. The boys may not wish to share theirs with the spouses . . . in fact they may not *dare* to. And it might even call for a quick disappearing act for the little lady who is wearing little more than a blush. Unlikely as this device is, it would efficiently accomplish this neat scene change for such "art lovers." In the meantime, it gives us a chance to show something new. How one valve can now extend a double acting cylinder, letting it remain extended when the valve is released, then retract the cylinder at the next actuation by using the new Ross momentary air index adaptor.

The Ross air indexing momentary has hundreds of serious uses

Now, a standard Ross Skyline valve, either solenoid or air operated can include this momentary air index adaptor. Then the first actuation will send the valve one way and it will stay in that position, even when the actuator releases. The next stroke reverses the valve, again it stays after actuator release, etc.

See your Ross representative for application information.



SEQUENCE OF OPERATION

1. Valve (A) is manually actuated, valve (B) reverses and stays put, keeping pressure on one side of double-acting cylinder.
2. When Valve (A) is manually actuated again, valve (B) reverses and stays put, keeping pressure on opposite side of double-acting cylinder.

Ross OPERATING VALVE CO.

131 East Golden Gate • Detroit 3, Michigan

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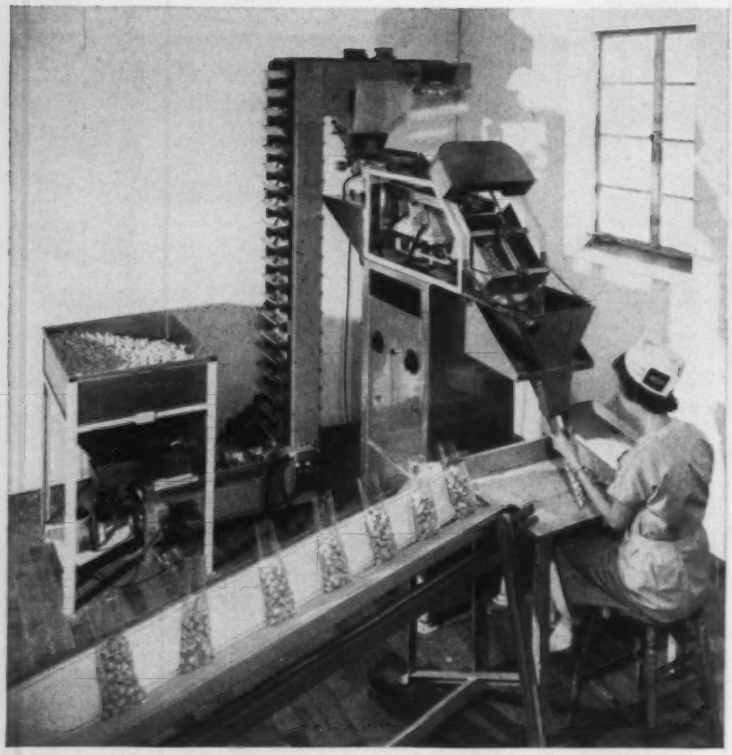


Sweet and Gentle... The Story at Wayne Candies

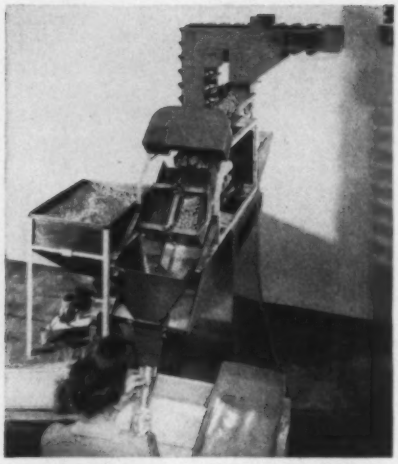
Wayne Candies, Inc. Fort Wayne, Indiana, recently installed a Wey-Mor automatic weighing and bag-filling machine to provide gentle treatment to a wide variety of candies. The equipment is used to handle items Wayne manufactures as well as those it re-packages under its own label. Some of the items handled on the Wey-Mor include Flavored Puffs, Cinnamon Imperials, Rum & Butter Toffee, Pineapple Slices, Rainbow Mints and a wide variety of other items.

Since installing the equipment, Wayne Candies has increased its production enough to save 10% on bagging costs and has reduced material losses by approximately 50%.

Extremely smooth, fast delivery is particularly important to assure perfect package appearance of a fragile candy like Wayne's Flavored Puffs. Wey-Mor meets all requirements because it features a vibratory feed along its entire length, not just at the bulk and dribble point. This eliminates friction and breakage of the candy.

Wey-Mor will be a "sweet" addition to your packaging operation! See how it can improve your product's appearance and cut your production costs. Write for full information.

Write for Illustrated Wey-Mor Folder that demonstrates true flexibility in production-line weighing.



Close-up shows detail of Lynch Wey-Mor. Vibratory feeder brings product forward to the bulk (2 outside channels) and dribble (center channel) point. Machine is quickly adjusted for any amount from 8 to 16 ounces . . . automatically discharges when proper weight is reached.

Wayne's packaging team includes a Lynch Robo-Lift which is synchronized with the Wey-Mor scale to assure a steady flow of candy. One girl keeps hopper filled, one handles filled bags, one labels them and another cases the finished product.

These are among the items Wayne Candies, Inc. packages with their Wey-Mor Automatic Weighing Machine: Flavored Puffs, Cinnamon Imperials, Rum & Butter Toffee, Pineapple Slices and Rainbow Mints are among the hundreds of varied items bagged on this high speed machine.

LYNCH
CORPORATION
Anderson, Indiana

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JULY 1958
Vol. 5—No. 7

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

ECONOMY BOOST

". . . I look to increased mechanization and automation to revitalize competition in industry, to stimulate industrial spending, and to provide many of the jobs that our burgeoning labor force will require . . ."—*Edward T. Dickinson, commissioner, New York State Department of Commerce.*

AUTOMATIC ASSEMBLY A NEW FACTOR

" . . . automatic assembly, seemingly the most promising field for product cost reduction, will have a profound effect on machining operations because of the close tolerances required. Once we get further into that field, there is no telling what drastic changes will be required in our metal removal equipment. Of course, the new approaches in manufacturing techniques will require a complete reappraisal of the economics of production, but we have no doubt that great technological advances will be justified . . ."—*Joseph H. Buhr, president, Buhr Machine Tool Co.*

BENEFITS FOR ALL

". . . automation is as important to a hospital, bank, or insurance company as it is to a guided missile plant or automobile assembly line . . . and to the extent that new capital and new leisure are created, all of the arts and sciences, including medicine, will benefit . . ."—*Malcolm P. Ferguson, president, Bendix Aviation Corp.*

FARMERS IN THE LEAD

". . . we hear a great deal about automation these days. Who would ever think that farmers lead in this important field? The last place many of us might think of looking for modern techniques is 'down on the farm' but the advances here are truly startling. In 1900 farming was carried on principally with animal and human muscle power, and much of our population was so engaged . . . One man now accomplishes what five did in 1900 . . ."—*H. J. Rand, president, Rand Development Corp.*

AUTOMATION A STABILIZING INFLUENCE

" . . . increased productivity through automation is one of the major barriers against the flood of a runaway inflation that would sweep away all our economic achiements. The threat of uncontrolled inflation rises when wages go up but output holds constant. Automation—in office and factory—has made it possible for us to keep our productivity moving ahead as our wages and salaries advance . . ."—*Robert E. Slater, vice president, John Hancock Mutual Life Insurance Co.*

CLERICAL AUTOMATION UPDATES DECISIONS

". . . the use of high speed information processing through computers is the solution for handling information at a pace equal to the development of manufacturing methods and industrial growth. Automatic computation in business is necessary to assist management in rendering sound and economical judgments without the handicap of information delays which tend to make their rulings out of date and possibly invalid . . ."—*Claude A. R. Kagan, Western Electric Co.*

AUTOMATION

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AUTOMATION is selectively distributed without charge to plant and business management responsible for initiating use of automation; to production, plant and systems engineers who plan and specify automated operations; and to engineers, designers and control specialists who design automatic machines, systems and plants. Copies are distributed, to U. S. and Canadian companies only, on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U. S. Government installations with similar responsibilities are also eligible.

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BPA NBP

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Actual Size

We've Miniaturized the Subminiature!

WEIGHT: *1 gram . . . 28 switches to the ounce . . . over 430 to the pound.* SIZE: *.500" long, .200" wide, .350" high.*
CUBIC CONTENT: *.035 cubic inches.* ELECTRICAL RATING: *5 amps-250 vac, 30 vdc. SPDT.*

After a long period of laboratory development, MICRO SWITCH announces this new, highly miniaturized precision snap-action switch and a complementary line of actuators.

We call it the "Sub-subminiature!"

This new "SX" basic switch represents an entirely new set of answers to the space-weight problems in dependable precision switching. It combines new small size with more than ample capacity for wide usefulness, meeting the pressing demand for miniaturization combined with reliability.

In its exacting development, many problems of design, testing and quality control presented themselves. However, 23 years of experience proved of immense value. As a result, a new standard has thus been set by which all precision switches must be measured.

This broad experience can prove of equal value to you. Send for more information about this new switch. Request Data Sheet No. 148.

—•—

MICRO SWITCH...FREEPORT, ILL.
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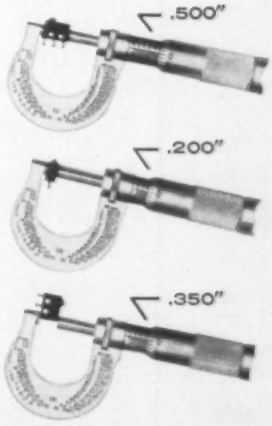
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario



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Honeywell
MICRO SWITCH PRECISION SWITCHES

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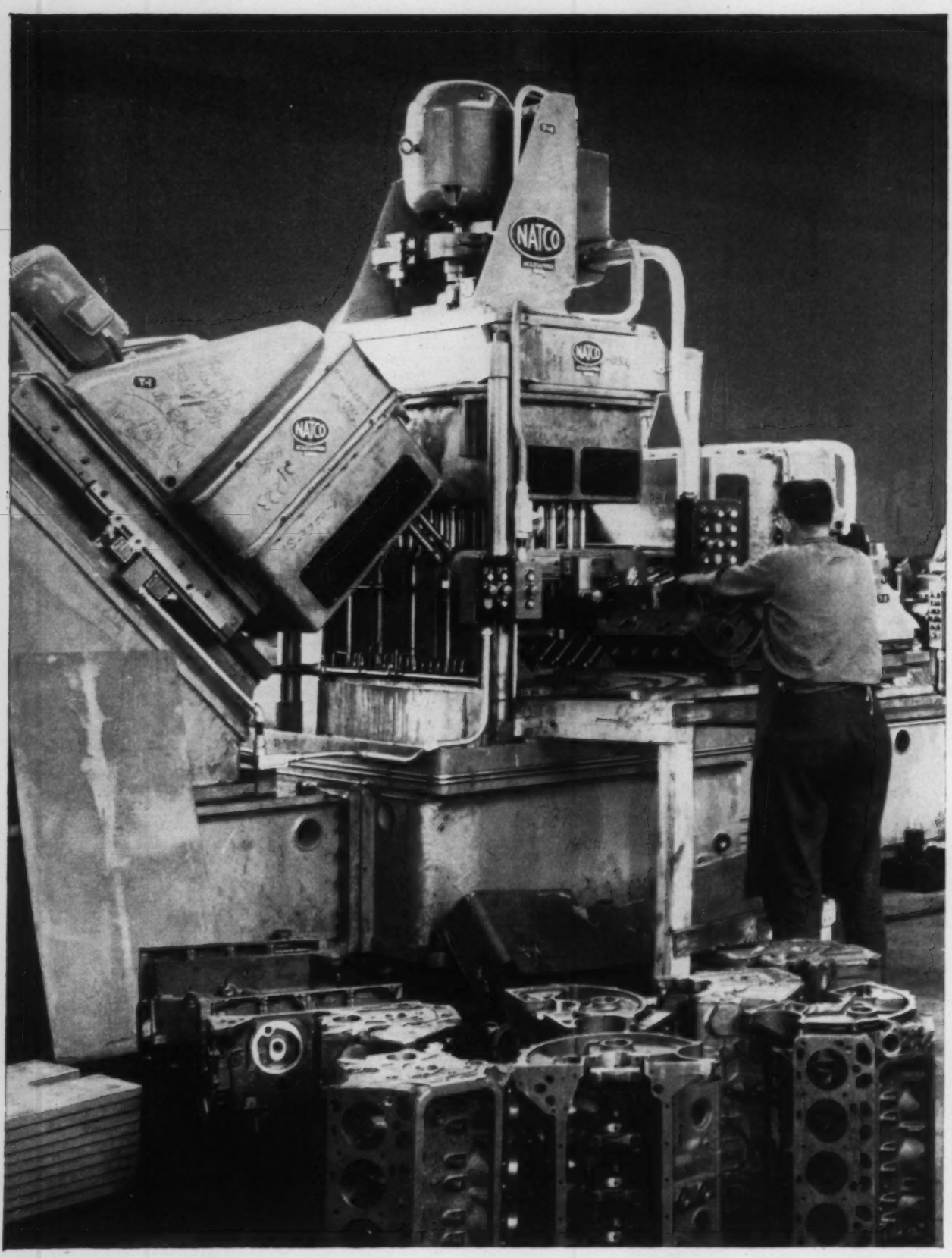
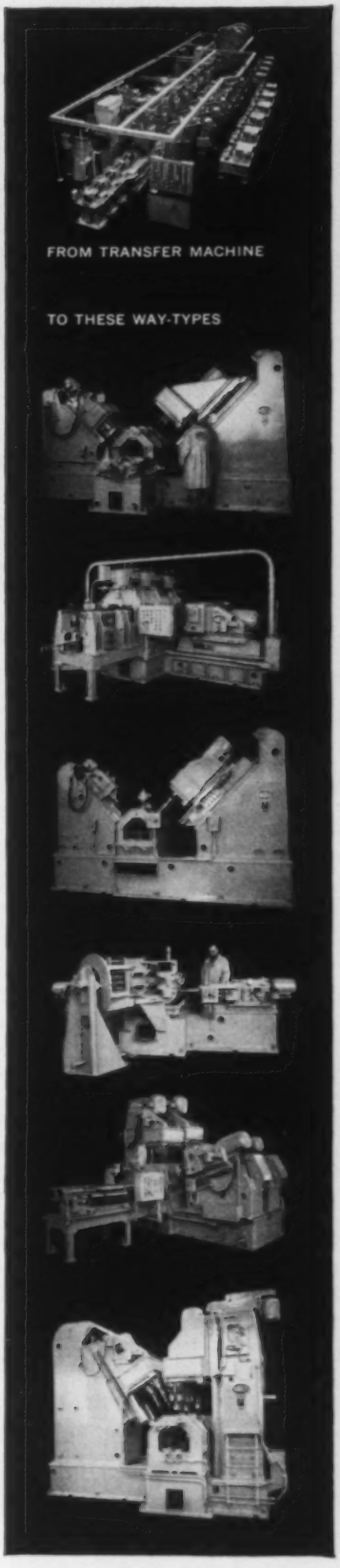

NATCO
NATCO
NATCO

Must your transfer machine go to scrap every time your model changes?

Certainly not. For example, the way-type machines shown here were once stations in an automated straight-line transfer machine. Now they will begin their second life as individual machines on a shorter-run lower-production assignment.

Each station in your Natco transfer machine—whether drilling, boring, milling, sawing or chamfering—is a machine tool in its own right. With modifications and new tooling, it may serve you for many years beyond its original "single-purpose" life.

When product changes call for new tooling, consider adapting the previous machinery to a new use—and realize substantial savings. Natco engineers and manufacturing facilities are at your disposal to make the necessary modifications. Call your nearby Natco representative today to discuss converting your equipment.



NATCO

Multiple-spindle drilling, boring, facing and tapping machines. Special machines for automatic production.

NATIONAL AUTOMATIC TOOL COMPANY, INC.

Dept. 294-P, Richmond, Indiana

Natco offices in Chicago, Detroit, Buffalo, New York, Boston, Philadelphia, Cleveland and Los Angeles. Distributors in other cities.

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The Arithmetic of Materials Handling

Fuller Airveyor unloads wood flour to two forty-five foot silos. Second Airveyor system reclaims material 360 feet to processing.

General Electric Changes From Bags to Airveyor . . . Cuts Handling Costs 60%

As part of a program to increase plastics production and reduce operating costs at its Pittsfield, Mass. plant, General Electric Company called in Fuller engineers to design systems for handling wood flour in bulk.

Wood flour—used as a filler in phenolic molding compounds—was being handled in 75 and 100-pound bags. Unloading one carload of bags required 16 manhours. Bags were loaded on dollies and wheeled to a distant elevator.

SAFETY FIRST—The two pneumatic Airveyor® materials handling systems, engineered and manufactured by Fuller Company, were installed by its parent company, General American Transportation Corp., providing undivided responsibility. This installation resulted in a 60% saving in handling costs! The two systems are handled by one full-time and one part-time operator. Manhours to unload one car have been reduced from sixteen to six!

In addition, all equipment is designed to conform to strict safety specifications set down by G-E engineers.

FLOW *YOUR* MATERIALS—The Airveyor is a system that flows your material through sealed pipes. It's fast, safe, and self-contained. The pipes can be placed close to ceilings, run underground or through walls.

Whether you process wood flour—or other dry granular materials—look into the many economies of Airveyor conveying. Write today for interesting, detailed literature on Airveyor and other Fuller pneumatic materials handling systems.

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G-196
1304

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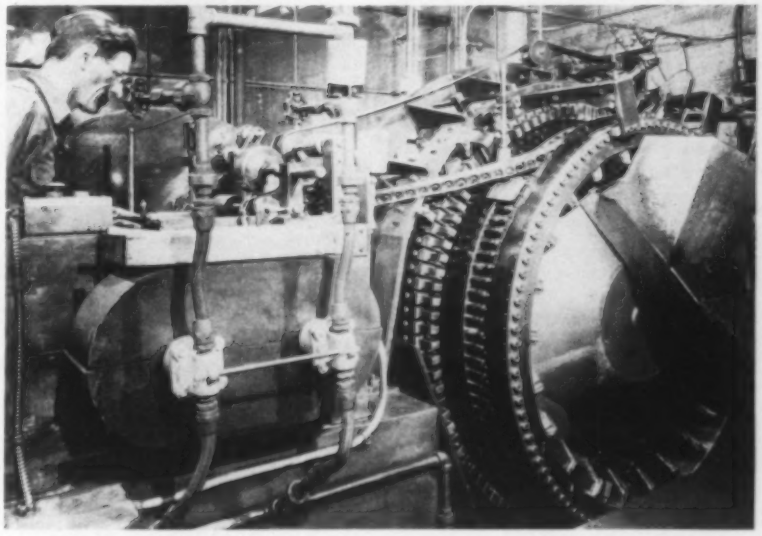
AUTOMATION news

Today's events and developments in the field of automation

Continuous Molding Process Makes Small Rubber Parts

CONTINUOUS process for custom molding natural or synthetic rubber into high-production, small rubber parts has been put into operation by Ohio Rubber Co. The automatic and continuous nature of the process makes possible production rates as high as 200,000 pieces per day from single-cavity, self-registering molds. While the use of such molds has always been recognized as the key to precision, their use has been too costly due to the low production rate per machine-hour which would result. The new process raises the productive capacity to the required level to make single-cavity mold use economically feasible.

Ten machines are in operation and each machine consists of a two-roll plasticizing mill feeding rubber strip material to 104 single-cavity, self-registering molds mounted on rotating wheels. As the wheels rotate, the molds close in sequence, cutting material from the strip. After one revolution, during which time the part is 90 per cent cured, the molds open and drop the partly cured parts onto a heated conveyor for final curing and discharge into tote boxes. After visual inspection on another conveyor line, the finished parts are packed for shipment.



CONTINUOUS rubber molding machine at a plant of the Ohio Rubber Co. molds small rubber parts from strip material. Ribbon of compound from plasticizing mill on left travels across top of rotary molding section and enters molds at right. Punched strip then returns to mill for reworking. Rubber part is partially cured during revolution of mold and is discharged from machine through chute at right for final curing on a heated conveyor.

FUEL PUMP oil seals molded by the new process are visually inspected prior to packaging for shipment. Vibrating hopper on right slowly feeds pieces onto conveyor.

The plasticizing mill continuously works material into a suitable sheet of the thickness required to mold the particular part. Rotary knives attached to the mill cut a strip from the sheet which feeds over the top of the machine, to the molds where a force plug cuts material from the strip and inserts it into the cavity mold, and back to the mill for reworking into sheet again.

The molding section of the line consists of two vertical 48-inch wheels mounted on a common axle and spaced several inches apart. The outboard wheel mounts the 104 mold cavities, and the inboard wheel holds the movable force plugs which are mounted on trunnions extending through the wheel. Each force plug is actuated by a spring-loaded toggle which opens and closes the mold by means of a follower riding on a stationary cam.

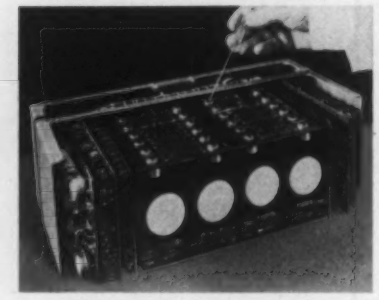
The new process is best suited for producing large quantities of small parts which require dimensional accuracy. Annual production of over a million pieces will normally be required to justify tooling cost and set-up. Diameters can be accurate to within plus or minus

0.003 to 0.005 inch, depending on size of part. With the present equipment, maximum part dimensions with 104 molds being used are 1¼ inch diameter and 1 inch thickness. By reducing the number of molds mounted on the machine, larger parts can be produced at a lower production rate. Actual limits depend on shape, total mass of part, and type of material.

Parts already in production include seals for automotive shock absorbers and universal joints, washers for quick-connectors, end caps for electric condensers, aerosol container valve parts, engine valve stem deflectors, and fastener components. Other applications of the continuous process will be industrial rubber parts used in large volume where dimensional accuracy is required.

World Data Processing Meeting Scheduled For 1959 In Europe

PARTICIPATION of the United States in the First International Conference on Information Processing was announced in May at the Western Joint Computer Conference. The meeting is scheduled for June 13 to 21, 1959, and will be held in either Paris or Rome. Sponsored by UNESCO (United Nations Education, Scientific, and Cultural Organization), the conference marks the recognition of information processing by automatic means as a universal technology.



ELECTRONIC digital display device has been developed by Hoffman Electronics Corp. for use in conjunction with decade counters, elapsed time indicators, frequency meters, punched card and taped readers, and digital volt meters. Two-inch cathode ray tubes provide readout for two, four, or six digits. Image is displayed by exciting the phosphor coating on face of tubes. Number waveshapes are generated by printed circuits and are formed by Lissajous patterns.

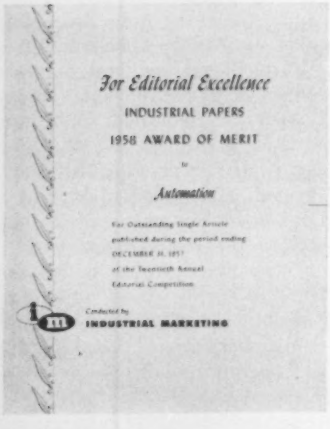
Technical papers presented at the conference will discuss methods of digital computing, logical design and common symbolic language for machines, automatic translation of languages, storage and retrieval of information, and pattern recognition and machine learning. A four-man committee, sponsored initially by the Institute of Radio Engineers, American Institute of Electrical Engineers, and the Association for Computing Machinery, will select outstanding American papers for inclusion in the conference. Chairman of this committee will be **Isaac L. Auerbach**, president of Auerbach Electronics Corp.

One of the major aspects of the conference will be an exhibition of machines and apparatus used in information processing. Participants also will travel to convenient European computer facilities for first-hand demonstrations of the latest techniques.

Canadian Manufacturing Firms Seek U.S. Products To Make

HUNDREDS of Canadian firms in all classes of manufacture are constantly searching for new product lines which they can add to their regular production, according to **M. J. Vechsler**, Canadian Consul and Trade Commissioner. If a new line is important enough, many of these firms are prepared to invest in new machinery and equipment to manufacture it.

A publicity and contact service has been developed in Canada to inform Canadian manufacturers of specific product licensing or royalty proposals made by U. S. firms. All Canadian firms who have expressed an interest in securing new products for manufacture on a license or royalty basis receive a regular bulletin from this service giving details of products available for manufacture. In addition, items published in this bulletin are republished in the Canadian business weekly *Financial Post* and in *Industrial Canada*, the monthly magazine of the Canadian Manufacturers' Association. In this way, it is possible for a U. S. manufacturer with a successful product, design, or process to bring it to the attention of

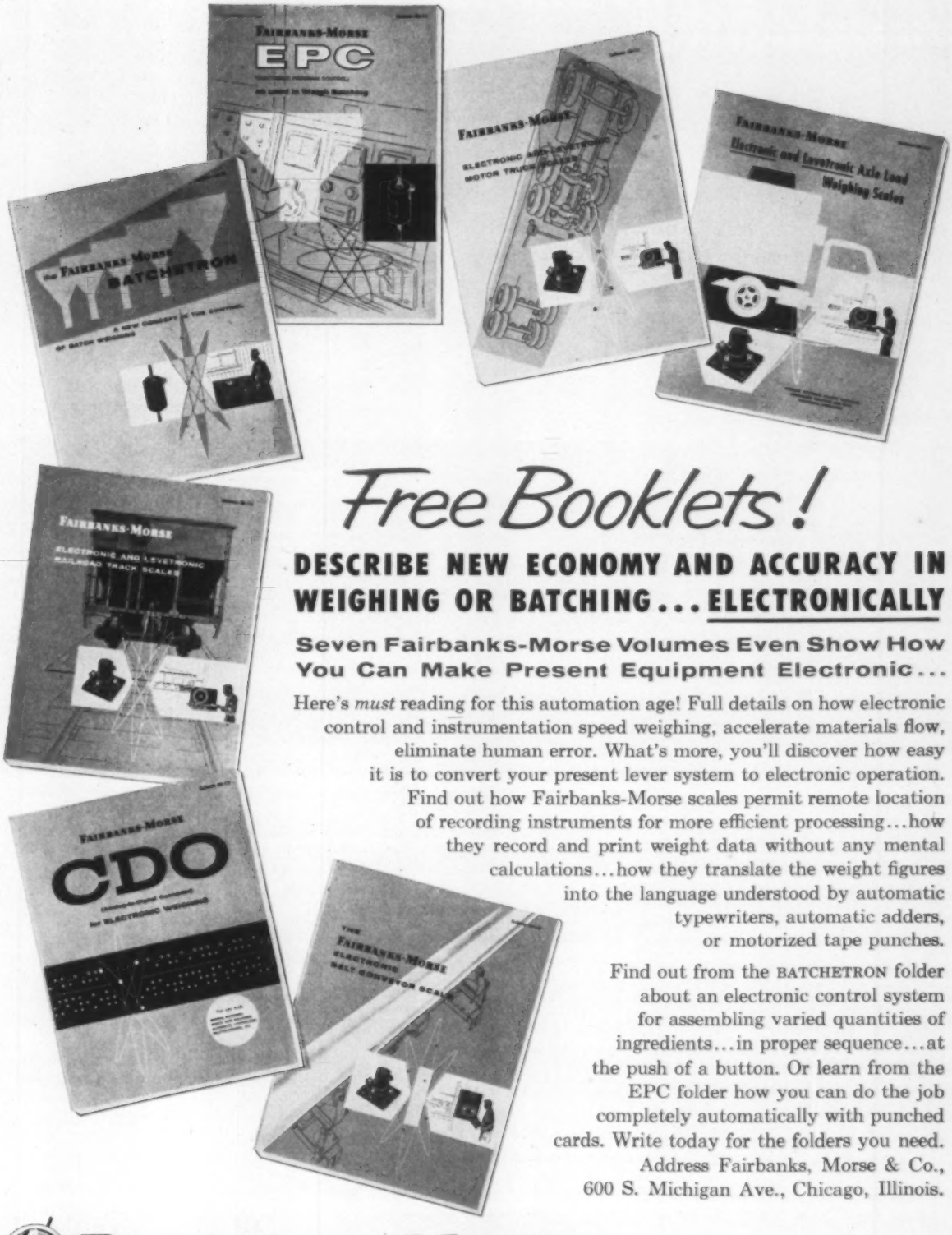


AUTOMATION Wins Editorial Award

RECOGNITION of high editorial excellence has been accorded to AUTOMATION in the recent 20th Annual Business Paper Editorial Achievement Competition sponsored by *Industrial Marketing*.

Certificate of Merit was awarded to AUTOMATION for an "outstanding single article of editorial service to the publications field" in an industrial classification for its prize-winning entry written by J. J. Combes and M. J. DePasquale entitled "Flow Measuring Devices—Key To Process Control" (September 1957, Vol. 4, No. 9). This fourteen-page feature illustrated the vital role of flow measurement in process operations and described in detail various devices for measurement of flow with their operating principles, advantages and disadvantages, and applications on stream. A highly successful article when it was originally published, the popular feature was subsequently reprinted as a pamphlet to fill reader requests.

Other business magazines published by Penton Publishing Co. also received recognition in the 20th annual editorial competition. Out of a possible 15 awards in the industrial publications grouping, Penton entries from AUTOMATION, STEEL, and MACHINE DESIGN won two plaques and three certificates of merit.



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DESCRIBE NEW ECONOMY AND ACCURACY IN WEIGHING OR BATCHING... ELECTRONICALLY

Seven Fairbanks-Morse Volumes Even Show How You Can Make Present Equipment Electronic...

Here's *must* reading for this automation age! Full details on how electronic control and instrumentation speed weighing, accelerate materials flow, eliminate human error. What's more, you'll discover how easy it is to convert your present lever system to electronic operation. Find out how Fairbanks-Morse scales permit remote location of recording instruments for more efficient processing...how they record and print weight data without any mental calculations...how they translate the weight figures into the language understood by automatic typewriters, automatic adders, or motorized tape punches.

Find out from the BATCHETRON folder about an electronic control system for assembling varied quantities of ingredients...in proper sequence...at the push of a button. Or learn from the EPC folder how you can do the job completely automatically with punched cards. Write today for the folders you need. Address Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Illinois.

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SCALES • PUMPS • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

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practically all Canadian manufacturers who are likely to be interested.

U. S. manufacturers wishing to take advantage of this service should get in touch with Mr. Vechsler at 1139 Penobscot Bldg., Detroit 26, Mich. They also should be prepared to furnish a full description of the product, estimated production costs, present sales volume, information on patent protection, kind of Canadian partner required, and general terms of licensing arrangement expected.

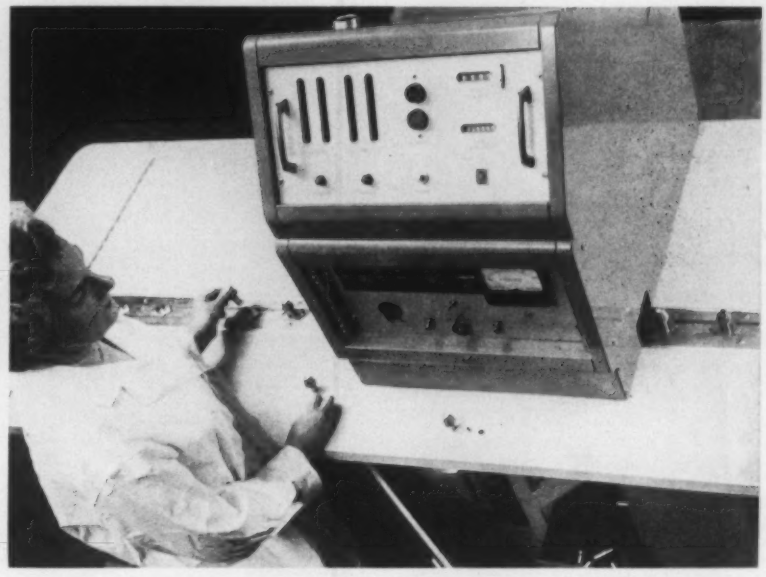
Equipment Leasing Trend To Increase In Next 10 Years

LEASING of manufacturing equipment will gradually increase during the next 10 years until many foundries, machine shops, steel fabricators, and metalworking industries will be operating entirely on leased facilities. This conclusion was drawn by **William R. Heins**, president of United States Leasing Corp., in a study made for the Foundation For Management Research.

The major advantage of leasing is that it frees working capital for expansion of sales, taking advantage of trade discounts, building of balanced inventories, and expanding research and development. The postwar trend towards expansion and diversity of product, coupled with a tight money market, has put pressure on working capital of industry. As a result, many companies are leasing instead of buying equipment today.

Leasing, according to the study, will become increasingly important in industries whose ratio of fixed assets to tangible net worth is greater than 30 per cent. Some companies with higher ratios than 30 per cent are selling their plant facilities and equipment and leasing them back on a purchase-leaseback. The object is to convert fixed assets to current assets.

Leasing appears to have three appeals, the study noted. First, in periods of tight money, a manufacturer does not have to tie up his capital in equipment. Second, at the end of a short-term lease, a manufacturer can always secure the newest type of equipment in place of obsolete equipment. Third, companies used to believe that they should rent real estate, but own equipment and other fixed assets. Since industrial real estate usually holds its value while equipment depreciates, many companies now own their real estate and rent the equipment items which decline in value.



INDUSTRIAL INSPECTION device called Automonitor employs radioactivity to inspect production line assemblies for the presence of internal parts. Developed by Nuclear Corp. of America for the U.S. Army Ordnance Corps, the unit can check completed assemblies at a rate up to 3000 per hour. Model illustrated inspects artillery-shell fuse heads to assure presence of complete firing pin assembly. Before assembly, internal parts are plated with small quantity of radioactive silver. Assembled fuse heads are carried through device by conveyor and are checked for radioactivity by a scintillator (geiger counter). Defective unit is automatically ejected from conveyor into bin below table. Counters on control board indicate number of units inspected and number rejected.

Automation Cited as Key To Economic Upturn

LACK OF AUTOMATED industrial facilities may be a major factor contributing to the current economic downturn. This idea was expressed by **John K. Hodnette**, executive vice president of Westinghouse Electric Corp., in a speech before the annual meeting of the Southern Research Institute during May. He continued, "Our best hope of getting out of the decline—and staying out of it—lies in more and faster improvement in our ways of doing and making things."

Mr. Hodnette said that it is up to industry to do what it can to return costs and prices to the more normal relationship of a free market . . . but the basic problem is one of lowering the costs of production. The quickest, most effective way to stimulate sales is by keeping prices just as low as we possibly can in the face of rising costs. The best way to do that, in the situation that exists, is to use better machines and methods to improve operating efficiency.

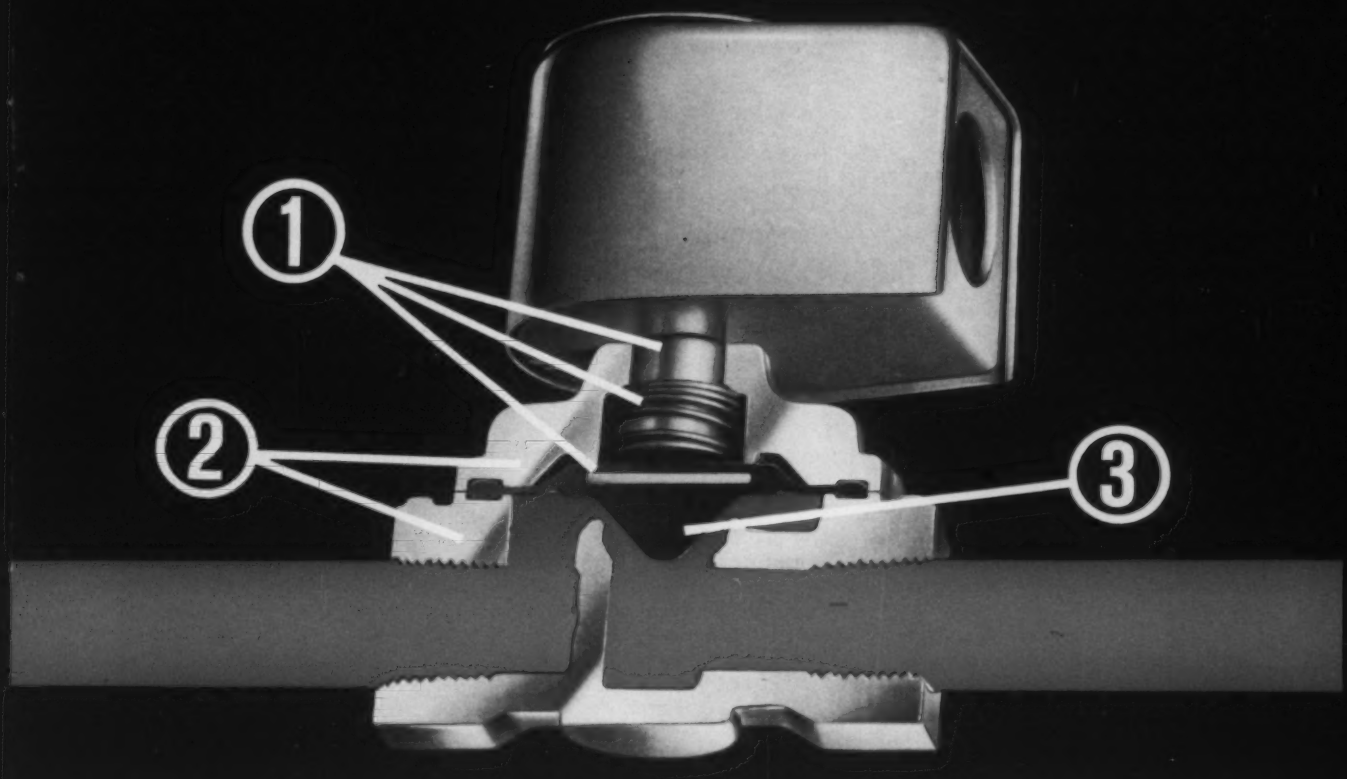
Automation is not something American industry can buy and install overnight, Mr. Hodnette continued. Rather, it is a whole way of industrial life that must be developed slowly and laboriously through years of experience.

Data Logging Firm Acquired By Hagan Chemicals

STRENGHTHENING its position in the instruments and controls field, Hagan Chemicals & Controls Inc. has acquired the name and tangible assets of the Kybernetes Corp., formerly a subsidiary of Self Winding Clock Co. Inc. Kybernetes manufactures automatic data logging and temperature monitoring equipment for industry.

In announcing the acquisition, **William W. Hopwood**, president of

SIMPLICITY, RUGGEDNESS, TIGHT SEATING,



WITH ASCO'S COMPLETE LINE OF 2-WAY SOLENOID VALVES

ASCO general purpose packless valves are now provided in a full ⅜" to 3" range . . . handle pressures up to 350 p.s.i. . . . ½" and ¾" sizes available to 1500 p.s.i. . . . provide dependable flow control for air, gas, water, light oil and other non-corrosive fluids.

Check these features of the Bulletin 8210A:

1. **Simplicity** in construction: Only three operational parts: all stainless steel core, stainless steel spring. Hycar diaphragm, ⅜"-¾" sizes . . . bronze piston ¾"-3" sizes.
2. **Ruggedness:** Forged brass bonnet and body insure freedom from porosity.
3. **Tight shut-off:** Assured by resilient disc construction.

Compactness: 2¾" face to face; 3¼" pipe center line to top of solenoid; 3-13/16" overall height. (Normally closed, ⅜" x ½" sizes.)

Mountable in any position: Normally open or normally closed.

Fast action: Rapid filling-venting operation permits cycling rate to 400 per minute.

All sizes have full area ports, continuous duty coils designed for low temperature rise and long life, and are available normally open or normally closed with standard, water tight or explosion proof solenoid.

Whatever the crucial factor in your flow-control application – reliability, compactness, high cycling rate – there is an ASCO valve that meets your need.

For Immediate Delivery . . .

World's largest stock of Solenoid Valves. A complete Solenoid Valve Stock List will be sent to you with your copy of Catalog No. 202.

New! Catalog No. 202 covers the ASCO line of Solenoid Valves. Write for your copy today.

SEE US AT THE ISA SHOW, BOOTH 1247, SEPT. 15-19.

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Automatic Switch Co.

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AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

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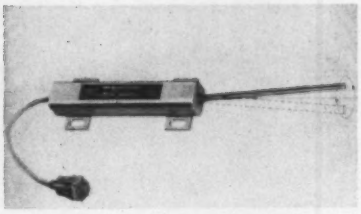
Hagan Chemicals, said that the use of automatic data loggers in industry is growing rapidly. He believes data logging equipment will be a standard requirement in power plant operation within the next decade. "In the process industries and refinery field," Mr. Hopwood explained, "one data logger can reduce a vast amount of information to a single typewritten sheet within a matter of seconds. This information can also be put on tape or punched cards for subsequent insertion into an electronic computer."

Analog Computer Handles Power Generating Scheduling

DEVELOPMENT of a new analog computer to solve the complex problems of economical interarea power generating scheduling has been announced by **H. R. Oldfield Jr.**, general manager of the Computer Dept., General Electric Co. The new computer simulates four generation and transmission areas and may be used for computations involving economic scheduling and tie line power cost calculations.

When utilized for calculating generating schedules, the computer simulates the system load and automatically includes the effect of transmission losses so that power interchange between each area is balanced economically. In addition, the unit calculates the incremental cost of power at tie points for economic interchange transactions. Basic theory for an economic dispatch for a four-area system was developed by **Dr. L. K. Kirchmayer** and **A. F. Glimn** of General Electric's Analytical Engineering Section.

The new computer uses solid state circuits which employ transistors and magnetic amplifiers. It is being constructed for the Niagara Mohawk Power Corp. and the New York State Electric & Gas Corp.



LINEAR MOTION potentiometer developed by Bourns Laboratories Inc. has a self-aligning shaft which enables measurement of linear displacement in cases where perfect alignment with the actuating member is not possible. The design eliminates side loads on the shaft and simplifies instrument installation. Single or dual potentiometer outputs are available in resistance values of 1, 2, 5, 10, 20, and 50 kilohms.

System Protects Pipelines From Pressure Surges

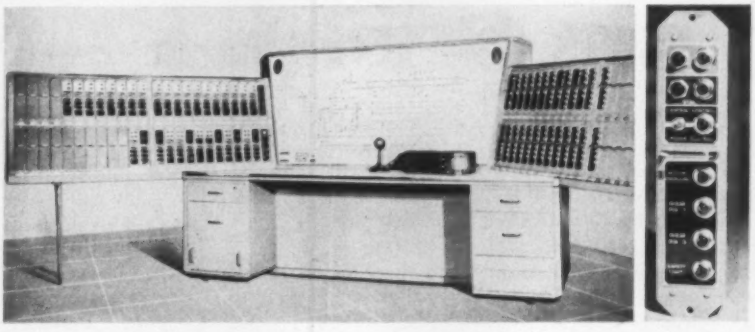
ALL-RELAY, self-checking system to automatically protect pipelines and pumping stations from dangerous line surges has been developed by Union Switch & Signal, Div., Westinghouse Air Brake Co. The system provides a protected transmission facility for instantaneously transmitting pressure surge information to upstream pumping stations where relays shut down pumps to prevent cracked pump cases or line blowouts.

Under normal operation, the system continuously transmits a 120 pulse per minute code from the monitoring location to one or more

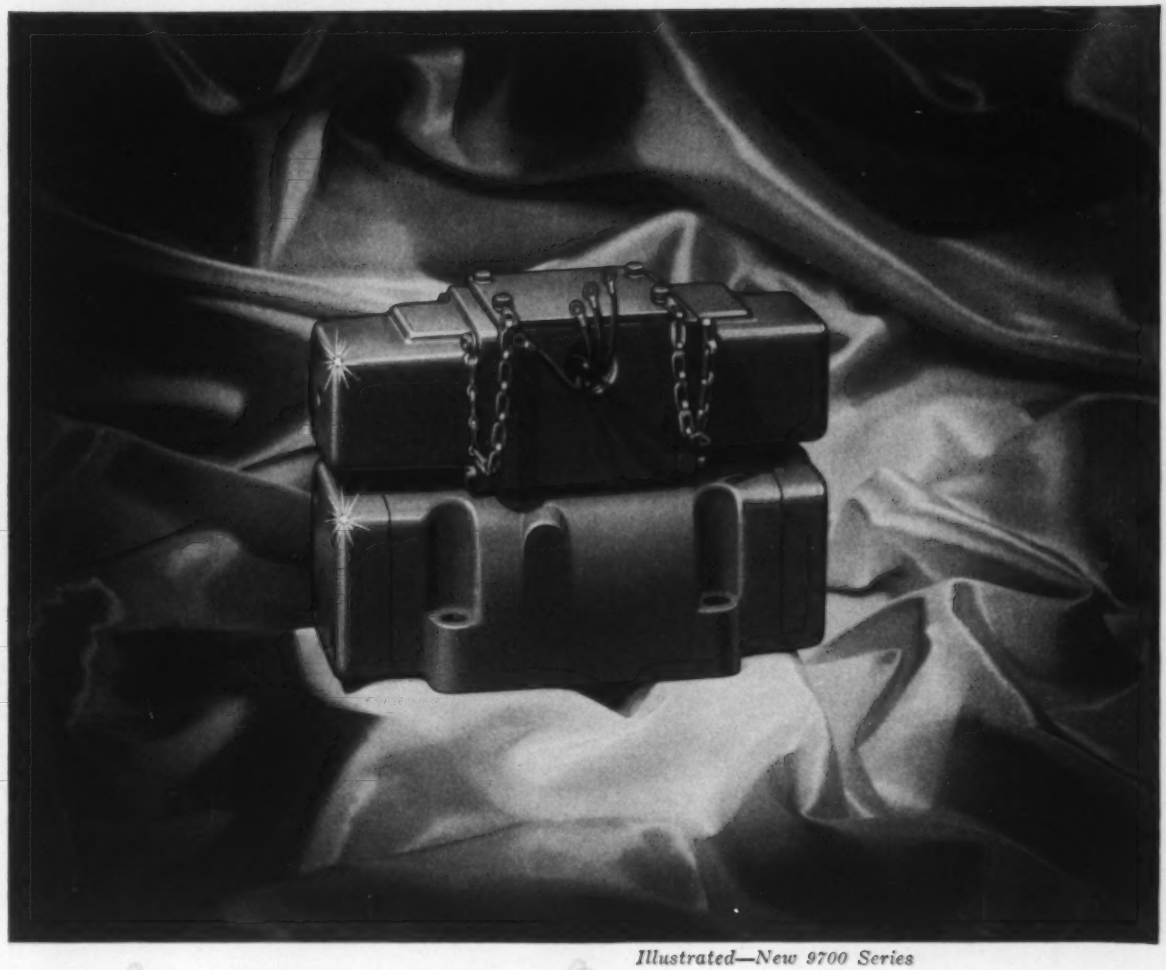
Trouble Spotting Control System Speeds Maintenance

MAINTENANCE control system for a new automobile assembly plant being built in Sydney, Australia, by the British Motor Corp. features delay saving innovations that could be applied to other high-production industries. The system was built by Bonochord Ltd., High Wycombe, England.

The new control system allows single point maintenance control over all critical conveyor lines in the automobile factory. Complete co-ordination of subassembly lines is necessary to insure that various components and mechanisms reach the main assembly line at the right moment for use. Delays caused by equipment malfunction or breakdown can cause complete stoppage of production and involve a loss in output totaling several vehicles. The maintenance control panel concentrates the control of all critical conveyor motors and other components at one central point, gives an immediate indication of trouble or breakdown, indicates the nature of trouble, and provides a means for contacting the nearest repair team.



Central feature of the control system is a large diagram depicting the layout of the production lines with colored lights showing the location of conveyor motors. On each side of the diagram are racks containing individual motor control panels. Each control panel provides means for starting or stopping a conveyor motor, a switch for transferring control of the motor to the maintenance team on the floor, and up to four warning lights for indicating the type of trouble, see insert. When malfunction occurs, a red light glows on the large diagram showing the location, and, simultaneously, trouble lights flash on the individual panel. Repair crews are then dispatched with advance knowledge of the type of breakdown.



Illustrated—New 9700 Series
Piggy Back Hydraulic Control Valve.

Look to Logan

the ultimate in hydraulic valve design

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A gift to you from Logansport Machine Company upon request.

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- ☐ 100-2 MILL-TYPE AIR CYLS.
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- ☐ ABC BOOKLET
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COMPANY _____

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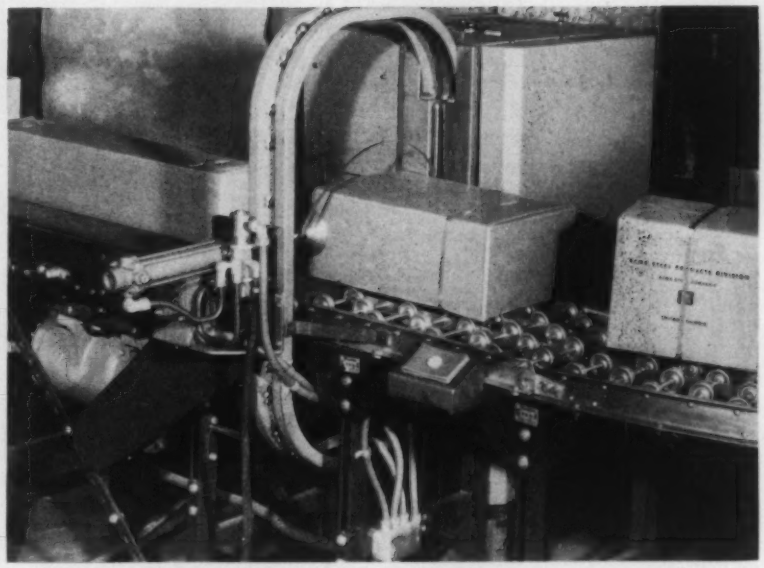
upstream pumping stations. Any interruption of this code by power failure, loss of code or carrier signal, will actuate visual and audible fault alarms but will not cause the station to shut down. When the alarm condition is cleared, the system is reset by pushbutton.

Also operating continuously at the monitoring station, but having no effect on the transmitter, is a 180 pulse per minute code. This code, in conjunction with a reliable pressure sensing device, constantly guards against line pressure surges. Any interruption of this code is also indicated by visual and audible alarms.

When a line pressure surge occurs, the pressure sensing device activates relay circuitry which permits the 180 code to key the transmitter, instead of the 120 code. The 120 code continues to operate locally. Upon receipt of the 180 code at the upstream station or stations, a code-following relay automatically shuts down the upstream pump station and initiates audible and visual alarms.

When the surge terminates, the circuit is automatically reset and the 120 code again keys the transmitter.



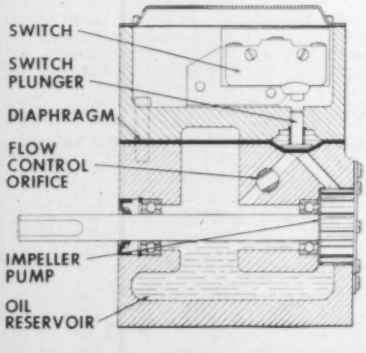
AUTOMATIC steel strapping machine developed by Acme Steel Co. applies strapping with uniform, predetermined tension to a wide range of packages without need for an operator. As the package moves into the machine on a short length of powered conveyor, the size of package is sensed, and the proper strapping pattern selected and actuated. An automatic ram stops and holds the package in proper position for applying one or more straps. Sealed joints are made with double spot welds eliminating the cost of separate seals.

Instrument Measures High Temperatures Accurately

RADIATION ratio pyrometer which will measure the temperatures of any solid, liquid, or luminous flame between 1500 and 4000 F without the need for making emissivity corrections has been developed by Shaw Instrument Corp.

Temperatures of items smaller than a lamp filament or as large as the sun can be measured to an accuracy within 20 F. The instrument will measure the temperature of flowing molten metal or moving objects inside a furnace rather than the furnace temperature. Readings may be translated automatically to control processing in steel melting, ceramic, glass, annealing and heat-treating, and similar applications.

The radiation ratio pyrometer consists of two units—a sensing head for detecting radiation and a control unit which interprets the information. Temperature is indicated on a meter calibrated directly in degrees. Automatic in operation, the unit has a speed response of a fraction of a second. Measurements may be made as close as a few inches or as far away as several hundred feet, depending upon the size of the object under test.

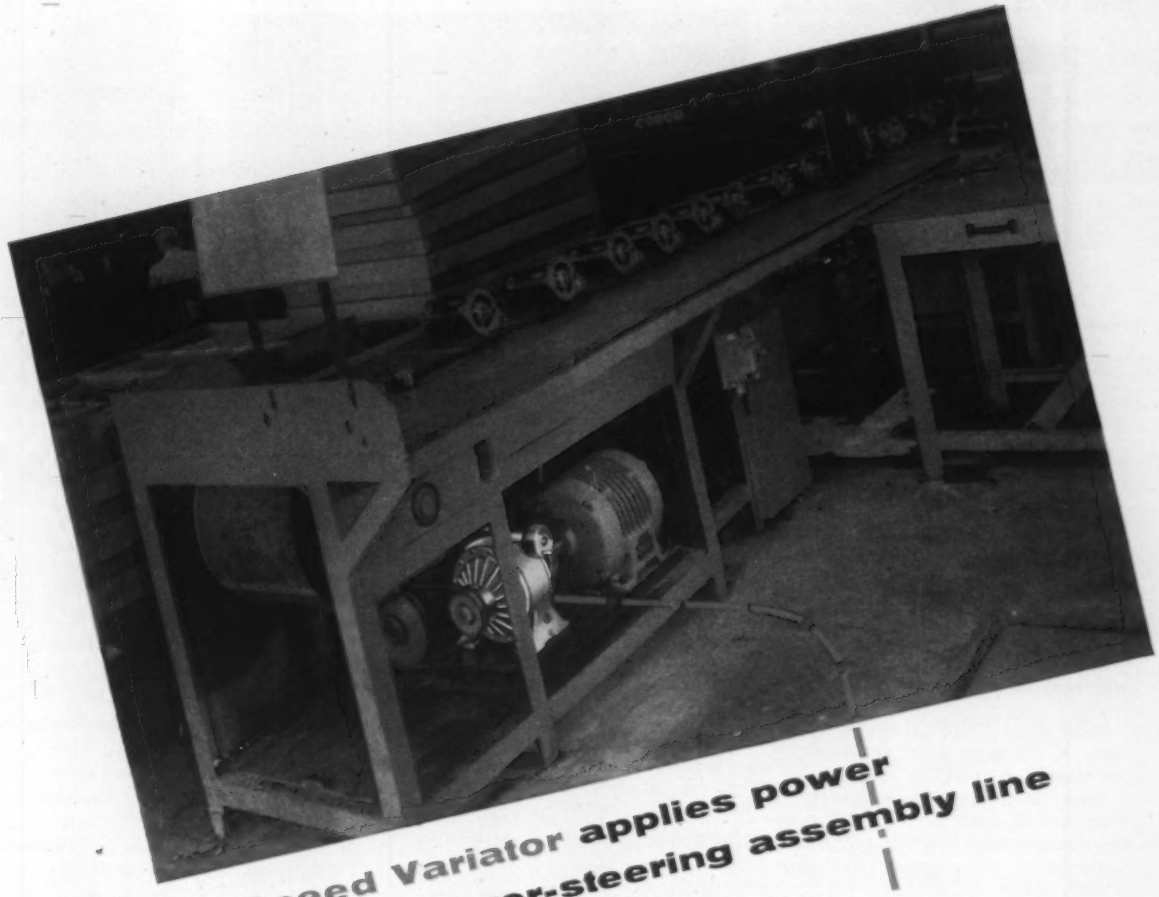


MOTION INDICATOR developed by the Bin-Dicator Co. can be attached to slow turning shafts to actuate an alarm system when the rotation of the shaft slows below operating level or stops. In normal shaft operation, impeller pump continually circulates fluid against a diaphragm which raises a spring-loaded plunger against a switch to close an electric circuit. When shaft slows down or stops, pressure against diaphragm decreases and plunger retracts to break electric circuit. Unit is designed for operation at shaft speeds of 10 to 150 rpm and is adjustable within this range by means of flow control orifice.

Multipurpose Grease Offers Cost Saving Opportunities

MULTISERVICE grease which offers cost savings for industrial plants because it combines the advantages of many different greases into one product is available from Socony Mobil Oil Co. Inc. Light tan in color, the new product withstands extreme pressures, has long service life, is water-resistant, and maintains chemical stability despite temperatures from minus 15F to plus 300F. It also protects against rust and corrosion and is compatible with other greases.

Cost savings are possible because one grade of grease can be used in many different machines in place of a variety of special-purpose



Cleveland Speed Variator applies power to power-steering assembly line

Providing variable speeds to the final inspection and assembly conveyer on a power steering gear generator line is a Cleveland Speed Variator. This Cleveland was chosen for its infinitely variable speeds which enable management to obtain a desired number of units per day by merely selecting a suitable conveyer output speed.

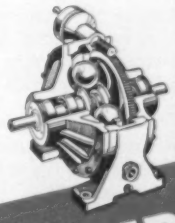
One of 22 Variators in the plant, this installation of a Cleveland Speed Variator has a side benefit to labor and management by eliminating problems stemming from disputed conveyer speeds.

Other advantages of Cleveland Speed Variators include: 1. Clockwise or counterclockwise input speeds to 1800 rpm; 2. Constant horsepower output over a 9:1 range, or constant output torque over a 6:1 range; 3. Rapid response to speed changes, precise adjustments, accurate adherence to settings; 4. Long life with minimum maintenance; 5. Ample bearing support for overhung pulleys on either input or output shafts; 6. Compact design.

Write today for illustrated Bulletin K-200 for complete specifications, sectional drawings and rating tables on the full line of Cleveland Speed Variators.

The Cleveland Worm & Gear Company, Speed Variator Division, 3265 East 80th Street, Cleveland 4, Ohio.

Sales representatives in all major industrial markets.
In Canada: Peacock Brothers Limited.



CLEVELAND SPEED VARIATOR

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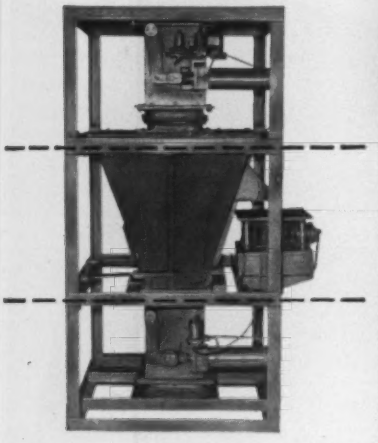
THE W-C HOPPER SCALE



standardized components adapt it to a full range of material handling methods, control instrumentation

Take a good look at this hopper scale. It has many practical features for almost any weighing application.

Take the upper and lower frames. They are designed to accommodate many standardized feed and discharge components: sliding gates, vibratory feeders, screw feeders and others. These units are pre-engineered; their performance has been fully proven in use. Costs are, therefore, correspondingly lower. Satisfactory operation is confirmed in advance.

Now look at the middle or hopper frame. Note the flexure mountings. They give stability to the unit and deliver a single component of force to the weight transmitter regardless of load distribution. The transmitter, itself, may be either electric or pneumatic; the signal can be used for weight indication, recording, automatic batching.

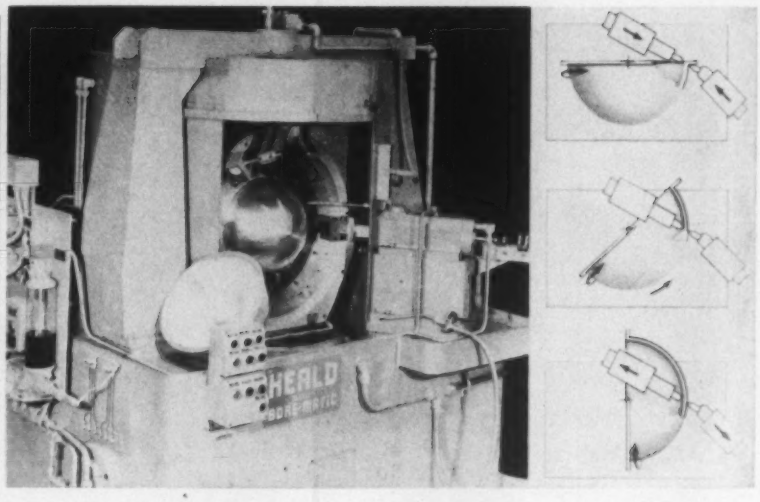
Write for Catalog 12.
Clear text, lots of pictures.

W-C

S.A. 1659

WEIGHING and Control COMPONENTS, Inc.
206-C Lincoln Ave., Hatboro, Pa.

Circle 663 on Page 127



SIMULTANEOUS spherical boring and turning of large aluminum hemispheres is accomplished on a machine developed by the Heald Machine Co. Operating sequence is shown in sketches at right. Work is loaded, clamped in position, and rotated until two boring bars reach a pre-set depth of cut. At this point, a turntable is automatically started, pivoting the rotating fixture and generating the spherical faces of both the inside and outside diameter simultaneously. At the end of 90 degree turntable rotation, the boring bars retract and the fixture returns to loading position. Size tolerance is held to plus or minus 0.0005 inch on I.D. and O.D. to maintain uniform wall thickness.

greases. In a large steel mill where the product was tested, the new grease replaced four other types. Fewer lubricants mean simpler handling, storing, and dispensing with subsequent reduced inventories.

In the past two years, more than 400,000 pounds of the new product have been tested in industrial plants under various conditions. It has proved successful with both plain and antifriction bearings under wet, dry, hot, cold, high-speed, and extreme pressure conditions.

HEADING a new firm called Ducker-Singer Co. is **William H. Ducker**, former general sales manager of an automation machinery manufacturer. The new company will manufacture automatic materials handling equipment and systems, and will offer a consulting service in product research and development. Early products to be introduced by the new firm are flexible track, flexible conveyors, automatic storage units, and several new electrical components.

SPOTLIGHTING PEOPLE

Carl I. Collins named vice president and assistant to the president, **Joseph W. Kennedy Jr.** named vice president in charge of Superior Steel Division, and **Reid M. Pittenger** promoted to vice president in charge of Ohio Seamless Tube Division in a series of executive promotions at Copperweld Steel Co. . . . **Michael Zajac** named vice president in charge of engineering at Buhr Machine Tool Co. . . . **Fred A. Schultz**, assistant secretary of Unity Mutual Life Insurance Co., elected international president of the National Office Management Association . . . **J. L. Molner** appointed chief engineer, **H. C. Matlock** named administrative engineer, and **B. C. Butler** appointed general superintendent for National Acme Co. . . . **Henry Wohlers** appointed staff engineer for the machine and tools division of Michigan Tool Co. . . . **John W. DeLind** elected to the board of directors of Sahlin Engineering Co. Inc. . . . **John A. McGuire** elected executive vice president of Thor Power Tool Co. . . . **Kenneth M. Lord** appointed director of engineering, Electronics Div., Stromberg-Carlson . . . **Oscar Ahlers** appointed general manager of Sheffield Corp. . . . **Robert F. Gladfelter** elected president of Detroit Power Screwdriver Co. . . . **William G. Zaenglein** appointed executive vice president and general sales manager of Clary Corp. . . . **M. Mark Watkins** appointed president of Conoflow Corp. . . . **Robert F. Norris** ap-

DRILLED 56,000,000 HOLES SAVED $140,000

that's automation with ARO PAR-A-MATIC DRILLS at progressive Michigan firm!

Running two years, ARO Par-A-matics have drilled 56 million holes in compressor pistons *without trouble* at a growing Michigan company.

Hole sizes: 1/16", 1/8". *Pistons drilled:* 7,000,000.
Savings: 2¢ direct labor per piston.

Let ARO Field Engineers help you automate your drilling with multiple Par-A-matic installations. Drill any number of holes at a time. Simple set-up . . . air-operated . . . adjustable stroke length . . . variable rate of feed. Write for bulletin 5546-T.

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ARO® AIR TOOLS
Also Air Hoists . . . Automation Tools . . . Paint Pumps . . . Material Handling Pumps . . . Industrial Lube Equipment

Circle 664 on Page 127

position or feed it faster

WITH AN AUTOMATIC

Feedall

hopper-load elevating feeder eliminates costly hand operations, saves time and speeds parts flow

SPECIFICATIONS—*Model 3000 Elevating Hopper Feed*

FEED[RATE: variable speed drive to match production rate of machine being fed.

WORK RANGE: rolling parts, 1" to 6" in diameter, 1/8" to 2" in length. Sliding parts, 1/8" to 2" in diameter, up to 6" long. Loading height is 62".

CAPACITY: 18 or 25 cu. ft. hopper. Overall floor space is 48" x 52".

DELIVERY ANGLE: 15° rolling parts, 30° sliding parts. 10° elevating angle.

DRIVE: 3/4 hp, 220/440V 60 cycle, three phase motor.

This multi-purpose feeder is just about the most versatile machine ever developed by Feedall. It provides in-process storage; elevates, orients and feeds work-pieces of wide variety in diameter and length. It handles both rolling and sliding parts. Typical are the varied parts shown above, merely suggesting the many versatile uses for this high-production unit.

It's fully automatic. Model 3000 replaces slow, time-wasting hand feed. The combination of magazine-loading and selectable speed permits continuous parts flow at any desired rate. *It's compact.* The "complete-package" feeder is entirely self-contained and is simple to fit into existing facilities. *It's a producer.* Model 3000 has proved its reliability and profitable operation in scores of installations. Construction is rugged; built for multi-million cycle operation.

Useful features of the Model 3000 include: electronic controls for any timing cycle, readily adaptable design to fit many special feeding jobs, portable and simple to re-locate, and adjustable elevating angle for special purposes.

Eliminate hand-feed, save operators and step-up production . . . with a Model 3000 Feedall. Full details are available in latest catalog, complete with estimating data sheet. Write for your copy today. Or if you have a special feeding problem, send us sample parts and brief data. We'll do the rest, promptly.

Feedall *Producers of automatic feeding devices*
FEEDALL, INC., WILLOUGHBY, OHIO

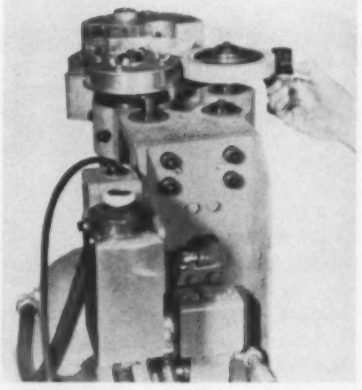
ELEVATING, BLADE, TUMBLE, VIBRATORY FEEDERS • TRANSFER AND ELEVATING CONVEYORS • SPECIAL SELECTOR DEVICES

Circle 665 on Page 127

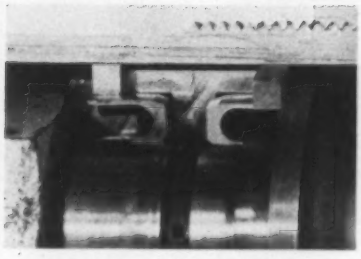
pointed plant manager of the Delaware, Ohio, plant and **Carl W. Lindahl** named works manager of the Columbus, Ohio, plant for the Denison Engineering Div., American Brake Shoe Co. . . . **D. Wayne Zimmerman** named manager of newly-formed Automatic Warehousing Branch, Pesco Products Div., Borg-Warner Corp. . . . **Roger A. Merritt** appointed manager of Cox Instrument Div., George Nankervis Co. . . . **A. E. Hein** appointed development engineer of bakery machinery and equipment at Baker Perkins Inc. . . . **Edward C. Helmke** appointed chief engineer of Gisholt Machinery Co. . . . **Austin Goodyear** elected president of Hewitt-Robins Inc. . . . **Elmer J. Renner** appointed vice president in charge of engineering for Stephens-Adamson Mfg. Co.

SPOTLIGHTING PRODUCTS

Safety overload device which protects high speed presses and dies against misfeed or doubling of material is offered by Precision Welder & Flexopress Corp. Device is based on detection of crankshaft and flywheel deflection during each press stroke. If two thicknesses of stock enter die as result of misfeed, deflection is greater than normal and is detected by unit, immediately stopping machine. Unit is effective



OFFSET PRINTING unit for automatically marking small parts while they move on a production line is available from Jas. H. Matthews & Co. Operating from a geared head motor and single revolution clutch, the unit prints specification data and trademark identification on round, flat, or irregular shaped parts. The unit is designed to replace hand marking operations and is readily adaptable to automated production lines.



METALLIC SEAL for hydraulic systems operating at 4000 psi and above has been developed by North American Aviation Inc. The design of the all-metal seal (patent pending) produces compression loads, effecting positive dynamic and static sealing. The unit can be used in temperatures from minus 65F to 750F and above. On Mark Couplings has been licensed to manufacture and sell the seals.

on stock 0.010 inch thick and heavier. . . . *Impulse latching relay* developed by Comar Electric Co. features an insulated rocker arm activated by a single coil instead of two coils. Contacts are set in one position when coil is energized or pulsed and return to initial position on next pulse. Unit can be used for machine controls, appliances, positioning devices and other applications where opposite switching is desired each time circuit is pulsed. . . . *Constant voltage reference supply* has been developed by Performance Measurements Co. to replace No. 6 dry cells in controlling, recording and indicating instruments. Dimensions of the new voltage supply are the same as those of the dry cell. Two knurled positive and negative terminals correspond to those of the battery, and three leads make connections to 115v line and ground terminals within the instrument. Operating at 1.5v and 6ma, the unit has plus or minus $\frac{1}{4}$ per cent stability over ac line voltage variations between 108 and 125v. . . . *Ultrasonic aluminum foil welder* developed by Gulton Industries Inc. uses no heat, flame, solder, or flux to produce a continuous welded seam between aluminum foils as thin as 0.0003 inch. Powered by a 100 watt ultrasonic generator, the device operates at 20,000 cycles which is above normal hearing range. Operating principle of the welder incorporates the use of high frequency sound waves to accomplish a molecular transfer or plastic flow between two similar or dissimilar metals resulting in a weld that is stronger than the two metals

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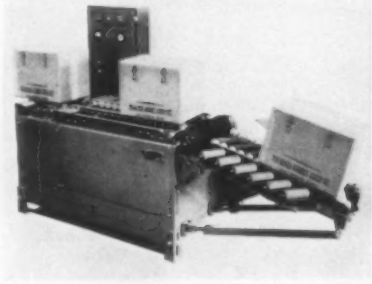
MODEL 145

This Selectrol Precision Checkweigher is capable of proving weight accuracies in the range of 1 part in 5,000 to 1 part in 20,000. Operation is fully automatic. An in-line "walking deck" type transfer mechanism places commodity on the weighing element and removes it. Selectrol, employing an extremely sensitive Shadograph Scale, provides visual weight reading. Electrical readout operates process controls as well as counting, recording and signaling devices. Capacities from 1 gram to 100 lbs. and operating speeds to 60 units per minute depending on capacity and accuracy required. Other Selectrol models are available with rotary tables and motorized conveyors. Write for Form 3347.

New Case and Bag Checkweigher



Model 1250 Selectrol for checking cases, cartons and bags from 20 lbs. to 100 lbs. offers accuracy one-tenth-of-one per cent. Speeds up to 30 units per minute. Model shown has over and under weight rejection. Also supplied with underweight rejection only or without rejection mechanism. Optional equipment available for machine control, recording, counting and visible or audible signaling. Write for Form 3280.

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Circle 666 on Page 127

Logan Conveyors have substantially reduced handling costs for this prominent manufacturer of bicycles. Assembling and inspection are performed on floor mounted Slat Conveyor and accessories are conveyed by overhead Trolley.

Locating ways to cut costs, always a good practice, becomes even more important as competition increases. A "head-to-toe" examination of every element of cost is the order of the day. Many companies are reducing operating expenses through improved materials handling.

Logan Conveyors, with built-in engineering "extras" are being called upon to solve handling problems for economy minded firms of all sizes. Most users report immediate savings in effort, time and space — savings that have materially strengthened their selling position. Certainly there is much to support those who believe that *sales do begin in the shop.*

Write today for more information or for nearest engineer to call.

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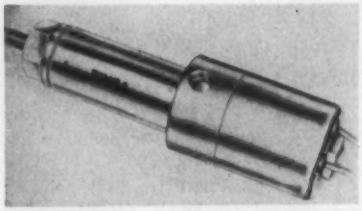
Logan Conveyors



STAINLESS STEEL air cylinder with built-in electric solenoid valve is available from Bimba Hardware & Mfg. Co. The single-acting, spring-return cylinder has a 1 1/16-inch bore and up to 3-inch stroke. A normally closed, three-way solenoid control valve is built on one end of the unit. Valves can be serviced and parts replaced without removing cylinder from line. Maximum operating pressure is 150 psi.

being joined. Welder can be used manually or may be built into automated production lines.

SPOTLIGHTING PLANTS

Cutler-Hammer Inc. has acquired the assets and business of Airborne Instruments Laboratory Inc. AIL will operate as the Electronics Division of Cutler-Hammer, retaining its name, officers, management, personnel, and line of business. . . . **Magnetics Inc.**, producer of magnetic components and devices for industrial control systems, has completed a 15,000 sq ft expansion in Butler, Pa. . . . **Alpha Engineering Works Inc.** has completed arrangements for the Arthur Colton Co. to sell, manufacture, and service the complete Alpha line of equipment for packaging aerosol-type, pressure-dispensed products. Alpha Engineering will continue its engineering, research, and development programs in the aerosol filling field. . . . **Magnetic Research Corp.** has announced the formation of a Magnepulse Division to manufacture a new line of magnetic pulsers and related equipment for military and industrial applications. . . . **Westinghouse Electric Corp.** has started construction on a new 62,600 sq ft manufacturing and repair plant at Glassport, Pa. . . . **Chemetron Corp.** is the new name of National Cylinder Gas Co. . . . **International Business Machines Corp.** has approved final plans for the construction of a new research center at Yorktown, N. Y. Construction will begin on the 450,000 sq ft building in the Spring of 1959. . . . **Taurus Corp.** is the new name of the Met-

Circle 667 on Page 127

ron Corp., manufacturers of mechanical components and assemblies for the electronics industry. . . . **Lovejoy Flexible Coupling Co.**, producer of power transmission equipment, has acquired controlling interest in Hi-Lo Mfg. Co. The new acquisition augments the present Lovejoy variable speed pulley line with a complete range of cam-controlled units from fractional to 5 hp. . . . **Electronic Associates Inc.** has entered the field of automatic data processing and process control through the formation of a Control Instrumentation Section.

MEETINGS AND EVENTS

July 28-Aug. 1—

Electronic Data Processing For Business and Industry. Workshop course on EDP application and equipment conducted by Canning, Sisson and Associates and to be held at Hotel Biltmore, New York. Further information is available from Miss Margaret Milligan; Canning, Sisson and Associates; 1140 S. Robertson Blvd., Los Angeles 35, Calif.

July 28-Aug. 1—

Gordon Research Conferences. Instrumentation Conference to be held at Colby Junior College, New London, N. H. Additional information is available from W. George Parks, Director, Colby Junior College, New London, N. H.

Aug. 5-7—

American Institute of Electrical Engineers. Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers to be held at Hotel Statler, Los Angeles. For further information contact G. C. Anderson, Autonetics Dept. 388-64, 9150 E. Imperial Highway, Downey, Calif.

Aug. 11-13—

Western Packaging & Materials Handling Exposition. 1958 Show to be held at Civic Auditorium, San Francisco. Additional information is available from William J. Wilkin, Clapp & Poliak Inc., 759 Monadnock Bldg., San Francisco 5, Calif.

Aug. 13-15—

Conference on Electronic Standards and Measurements. Jointly sponsored by AIEE, IRE, and the National Bureau of Standards, conference will be held at the NBS Boulder Laboratories, Boulder, Col. Additional information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Aug. 19-22—

Western Electronic Show and Convention. Sponsored by the Los Angeles and San Francisco Sections of IRE, and the West Coast Electronic Manufacturers Association. Event to be held at the Pan Pacific Auditorium and the Ambassador Hotel, Los Angeles. Additional information is available from WESCON headquarters, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Sept. 7-12—

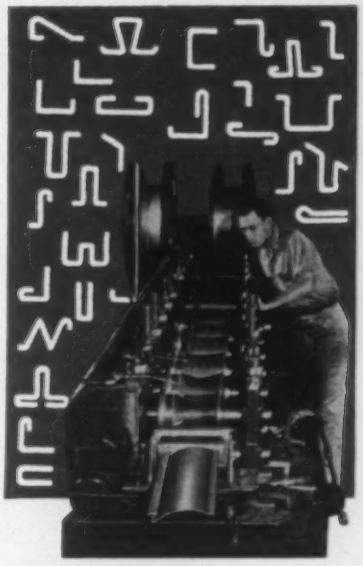
American Chemical Society. National Chemical Exposition and Conference to be held at International Amphitheatre, Chicago. Additional information is available from ACS headquarters, 1155 16th St. N.W., Washington 6, D. C.

Sept. 15-17—

American Society of Mechanical Engineers. Process Industries Conference to be held at Hotel Statler, Buffalo, N. Y. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 15-19—

Instrument Society of America. 13th Annual Instrument-Automation Conference and Exhibit to be held at Convention Hall, Philadelphia. Additional information is available from Fred J. Tabery, 3443 S. Hill St., Los Angeles 7, Calif.



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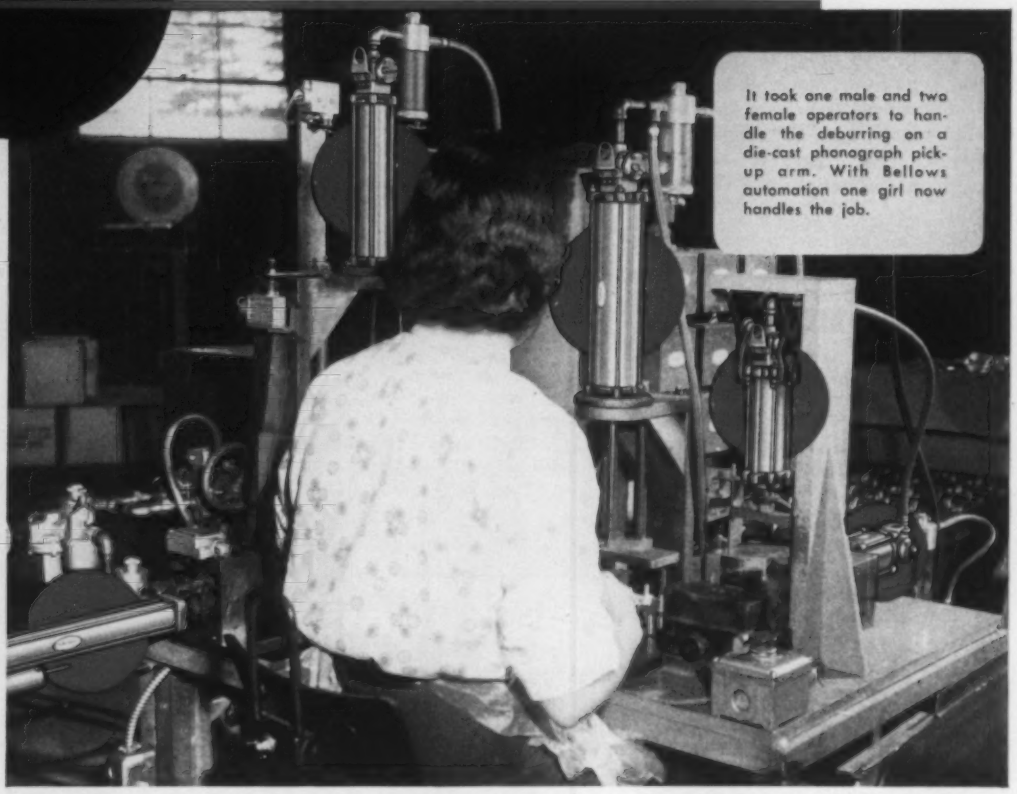

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Circle 669 on Page 127

By JAMES C. KEEBLER Managing Editor

View shows Vickers sponsored Third Production Machine Tool Hydraulic Forum in session. System enables all conferees to participate in the conversation and all comments to be tape recorded. To get into the act, an individual raises the number card of the nearest microphone. When a moderator states recognition of that number, the control operator connects that microphone into the sound system and signals "on the air." Participant first identifies himself, then states his views.

Bridging the Gap

IT CAN be said without fear of successful contradiction that most of the problems impeding industrial progress have their roots in matters of adult education. (Child labor is still outlawed.)

If You Only Knew

Most generally the problem is with the other guy. If he could only be made smarter we'd have less scrap. Yet in the words of a well-read tool-crib philosopher: (who must here remain unnamed) "A stupid jerk is not the guy who's just learning today what you first became aware of yesterday—he's you the day before."

Though sound educational philosophy is now-a-days pouring from all corners of the nation, most of the critics of another's educational shortcomings must plead guilty to having once lacked the knowledge or insight they see lacking in others.

Surveying learned developments in the broad field of automation has led this member of an enterprise dedicated to the propositions of adult education to humbly jot a few notes of tribute to all those who struggle to nobly advance the cause.

Automakers are great educators. From the floor sweepers, who must learn how to operate their machines, to the presidents, who must learn how to testify to Congress, the need is clearly felt. From the apprentice course to the company-owned institutes of higher learning, the challenge is being accepted.

This is a perpetual thing. The more a man knows, the better qualified he is to move up to a higher spot and leave a vacancy to be filled by someone else who must then learn what his predecessor knew. The promising process man who was sent off to hydraulics school returns to make his mark and gets promoted to supervisor of the plant maintenance office. This leaves the director of production engineering looking for another trainee. The need for educated men to fill the gap is universal.

Gaposis

One of the spots where there's too often a gap that stifles progress is in the development of manufacturing systems. The gap in question is between those who engineer new components and equipment and the users who must operate these developments.

The components maker has the constant problem of convincing the machine builder that he should upgrade his line by giving this or that new device a try on one of his model B machines. The machine builder may be reluctant to try it on the grounds that the risk involved might jeopardize his position with the users who seem semi-content with the present offering.

On the other end of the stick the user who is just learning (or recently learned) how to operate the system of components now in vogue on the model B is too busy keeping this one running to be anxious to take a crack at another brainstorm.

In this end of the business a successful application is not enough. The success story must be told and the technology must be learned by those who are to use it. This too presents a problem. The student must have passed the prerequisites or the message of the new knowledge will shoot right over his head. This gap in know-how status between those who've solved the problem and those who've still got it is often hampered by an inability to understand the new developments. Terminology alone is a big barrier.

Hydraulically Educated

The frontispiece of the program for the Third Production Machine Tool Hydraulic Forum bears witness to the testimony just given. It tells that the Forum was based on the thought: While oil hydraulics is of vital importance to the mass production industries, the art is still so young that there is a lack of common understanding of many important details of its application. This occurs among users and builders of hydraulically operated machinery as well as among the manufacturers of accessories and fluids for these machines.

The forum's sponsors, the Machinery Hydraulics Div. of Vickers Inc., should be congratulated for another contribution to adult education. Aside from the obvious fact that 133 registrants, representing

various phases of hydraulic activity, couldn't help but learn from an opportunity to swap ideas where each could be heard by all, there's the additional fact that such a gathering represents a broad spread of learning and experience so far as hydraulics is concerned, and offers an ideal place to practice spanning techniques for those who desire to bridge the gap.

With one-third of the registrants representing the auto industry as users of hydraulically operated machine tools, and one-third representing the builders of such machines, the remainder represented: 1. Users from other industries. 2. Suppliers of fluids and accessories. 3. The technical press (which has a big stake in adult education.)

While some are quite concerned about the performance characteristics of electrohydraulic servo valves others leave you with the impression that a servo must be something you'd expect to find in a restaurant.

Discussion sessions were ably moderated by Cross Co.'s engineering vice president, Kurt Tech and by Chrysler's plant manager of the Kokomo Torque-Flite Plant, J. R. Cypher. The agenda of points submitted in advance by the participants included pumps, fluid motors, warehousing of hydraulic components, fluids, valves, fittings and tubing, circuits and systems, seals and packings, and strainers and filters.

In addition to the agenda of discussion points and a keynote address by A. V. Bodine, president of Bodine Corp. and now president of the National Machine Tool Builders' Association, the program included papers by authors familiar with certain phases of hydraulics. Glea Hyland, hydraulics engineer of the Sundstrand Machine Tool Co., spoke on slow-rate feed control. A group of papers on electrohydraulic controls included: *Electrohydraulic Valves As the User Sees Them* by Robert Sedgwick, assistant chief engineer of Servo Machine Tool Div., Kearney & Trecker; *Programming Methods for Automated Machinery* by Joseph Crabtree, director of application engineering of Univac Tab Div., Remington Rand Corp.; and *Electrohydraulic Design for Easy Maintenance* by Byron Ledgerwood, managing editor of *Control Engineering*.

George Bonnell, service manager of Vickers Machinery Hydraulics Div., was assisted by J. J. Yates, hydraulic and electrical engineer of the Detroit Diesel Engineering Div. G.M.C. in presenting a paper on *How Planned Preventive Maintenance Can Resolve Many Hydraulic Problems*.

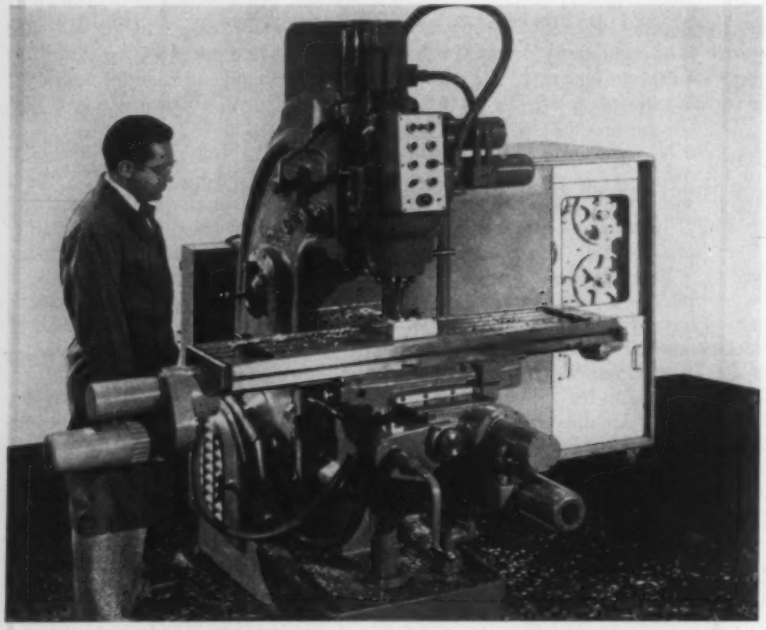
The educator's role is to lead and yet follow. The contributed agenda followed present practice in the auto industry. The papers lead the way to more knowledge of developments that (though not now commonplace in auto plants) represent the gap to be bridged.

Servo-Controlled

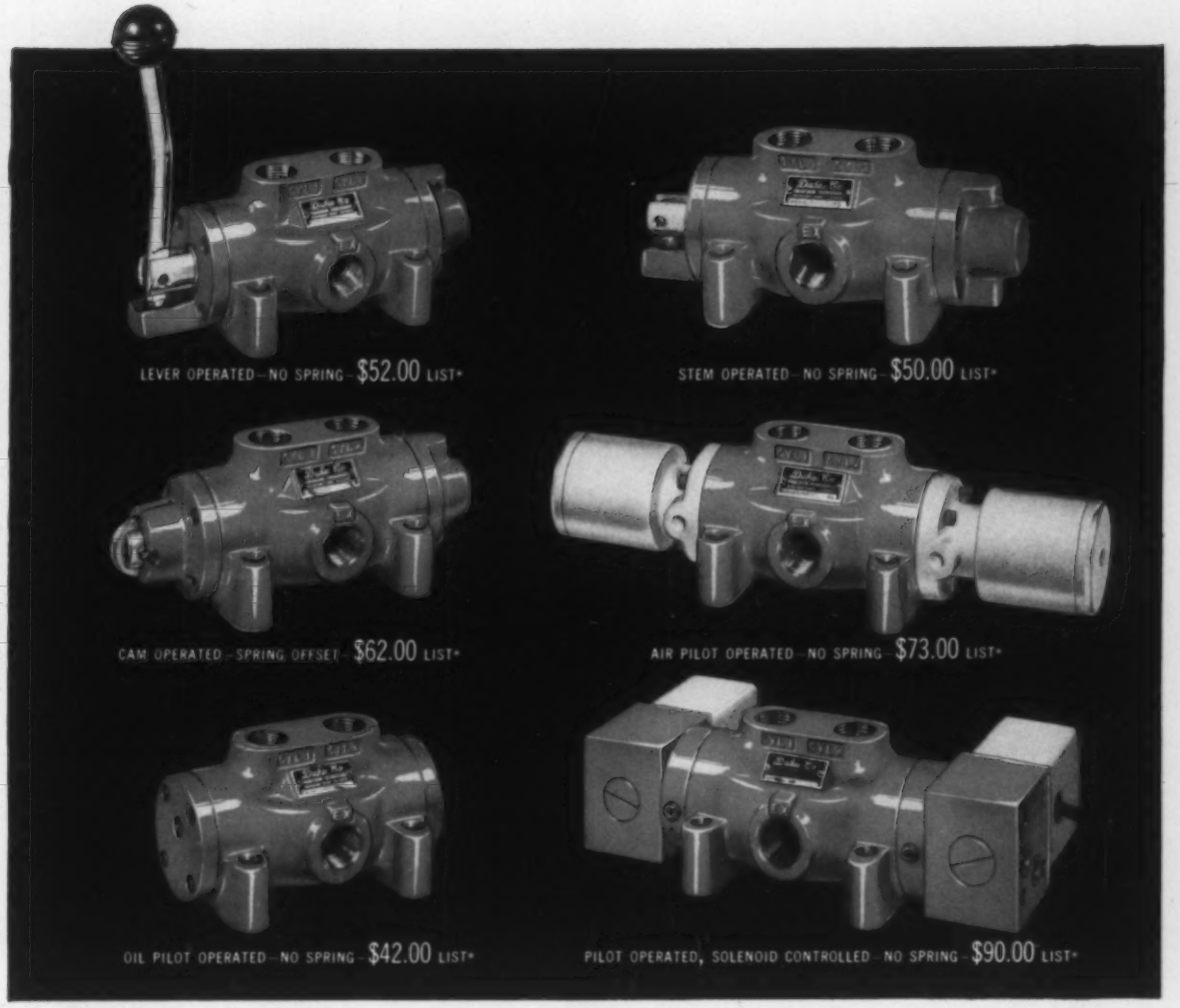
Sedgwick's presentation told how numerically controlled milling machine tables are positioned by circulating-ball lead screws driven by hydraulic motors that are controlled by electrohydraulic servo valves. He named the servo valve as the Hi-Fi element in the machine—challenging the machine tool designer to: ". . . bring the performance capabilities of the rest of the machine up to where he can make good use of what the servo valve can do."

In tape controlled machine tools described, the servo systems use feedback signals to report the actual position of the table. The comparison of tape command signal with feedback signal results in an actuating signal that controls the servo valve. The valve setting changes with different values of input current such that quantity of oil flowing through the valve is proportional to the current in the actuating signal. The servomotor moves an amount corresponding to the quantity of oil given to it by the servo valve. This causes the lead screw to position the table in accordance with the instructions on the tape.

Though the big market for such machine tools to date has been to the small-lot producer, and though the automakers' shops are not now loaded with such equipment, high-production equipment has a need for programmed control of its operating functions. In their present outlook on flexibility in production machines the automakers are certain to see advantages in numerically programmed, servo-controlled machine actuation. Continued dissemination of information on these developments is essential to bridging the gap.



Knee-type vertical milling machine equipped with tape-programmed numerical control system is offered by Kearney and Trecker. Model shown has Electronic Control Systems' Digimatic control. Two other control systems (Bendix and G.E.) are available on this line of K & T machines.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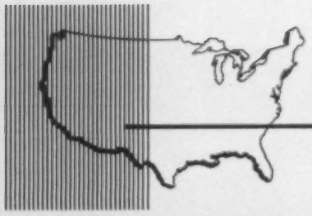
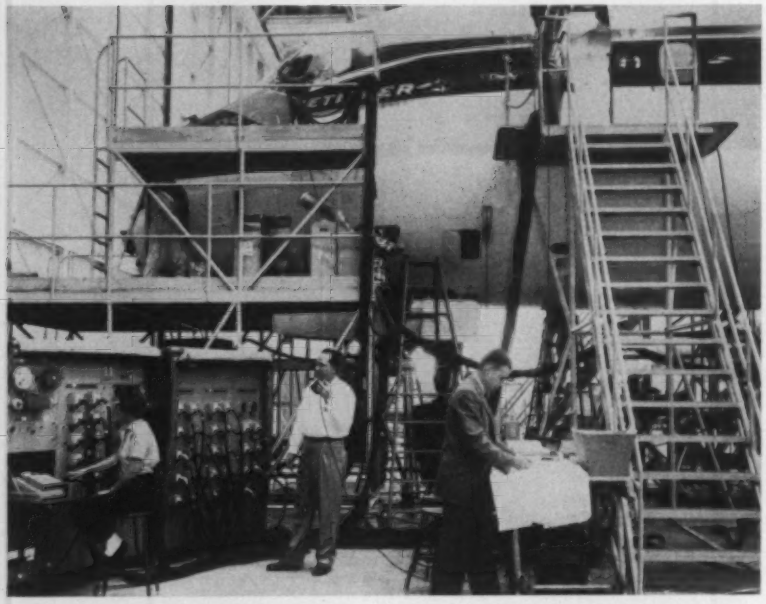


western roundup

By GILBERT C. CLOSE
Hawthorne, Calif.



Tape-controlled automatic electric circuit tester designed and perfected by Douglas Aircraft Co. is used to economically and accurately test the 3500 separate electrical circuits installed in each of the new DC-8 jetliner transport planes. Testing unit checks circuit for open, grounded, shorted, or crossed connections. If circuit fails to function properly, the operator can set up a series of tests to analyze the trouble and relay the information by telephone to a trouble-shooter inside the airplane.

Automatic Circuit Tester

AUTOMATION often treads strange byways to obtain desired results. One of these unfamiliar detours is now being explored at the Long Beach plant of Douglas Aircraft Co. where the new DC-8 jetliner transport airplanes are being produced. The DC-8 contains approximately 3500 complete and separate electrical circuits which must be checked and tested before the airplane takes to the air. This would be a time-consuming and costly task using conventional test methods. Douglas engineers have designed and perfected a tape-controlled automatic electric circuit tester which can complete the job in a fraction of the time required by conventional test methods, and do it so accurately that nothing is left to chance.

In using the automatic circuit tester, the individual circuits in the airplane are each given a number. This data is fed into the tester in the form of a coded tape. As changes are made in the wiring diagrams during the development of a new airplane, only the tape needs to be changed. This eliminates the necessity of re-wiring dozens of conventional test setups as the work progresses.

The automatic tester has a printer-register which records up to ten digits, and also stores information. It determines automatically whether a circuit is open, grounded, shorted, or crossed. Immediately after the test, the printer on the automatic tester prints out the circuit number tested and indicates an "OK" in black or an 'NG" in red. If a circuit fails to function properly, the operator uses a manual keyboard to set up a series of tests to analyze the cause of the trouble. At the same time he communicates by telephone with a trouble-shooter located inside the airplane who makes the necessary changes to correct the defective circuit.

The idea behind this testing device is neither complex nor mysterious. It points out that automation, when intelligently applied, can be used in complex test and inspection work just as effectively as in the production of complex components.

Machining Conference...

Last year more than 800 engineers and executives attended the Third Annual Contour Machining Conference held in Los Angeles during October, 1957. Plans for the Fourth Annual conference are underway and attendance is expected to increase to over 1000. The location and dates of the next meeting have not been announced as yet.

In three short years the Annual Contour Machining Conferences have become an institution in the art of applying this technique to machine automation. They are held by True-Trace Sales Corp., producer of hydraulic tracing equipment. Commercialism is rigorously omitted from the speeches and various technical papers presented at the conference. In effect, these conferences have the ethical aspects of similar meetings sponsored by technical societies.

As the name implies, the conferences cover the subject of contour machining and all facets of production affected by it. A few of the papers presented at the 1957 conference were "Achieving Fine Tolerances In Tracer Controlled Contour Turning" by J. M. Case of

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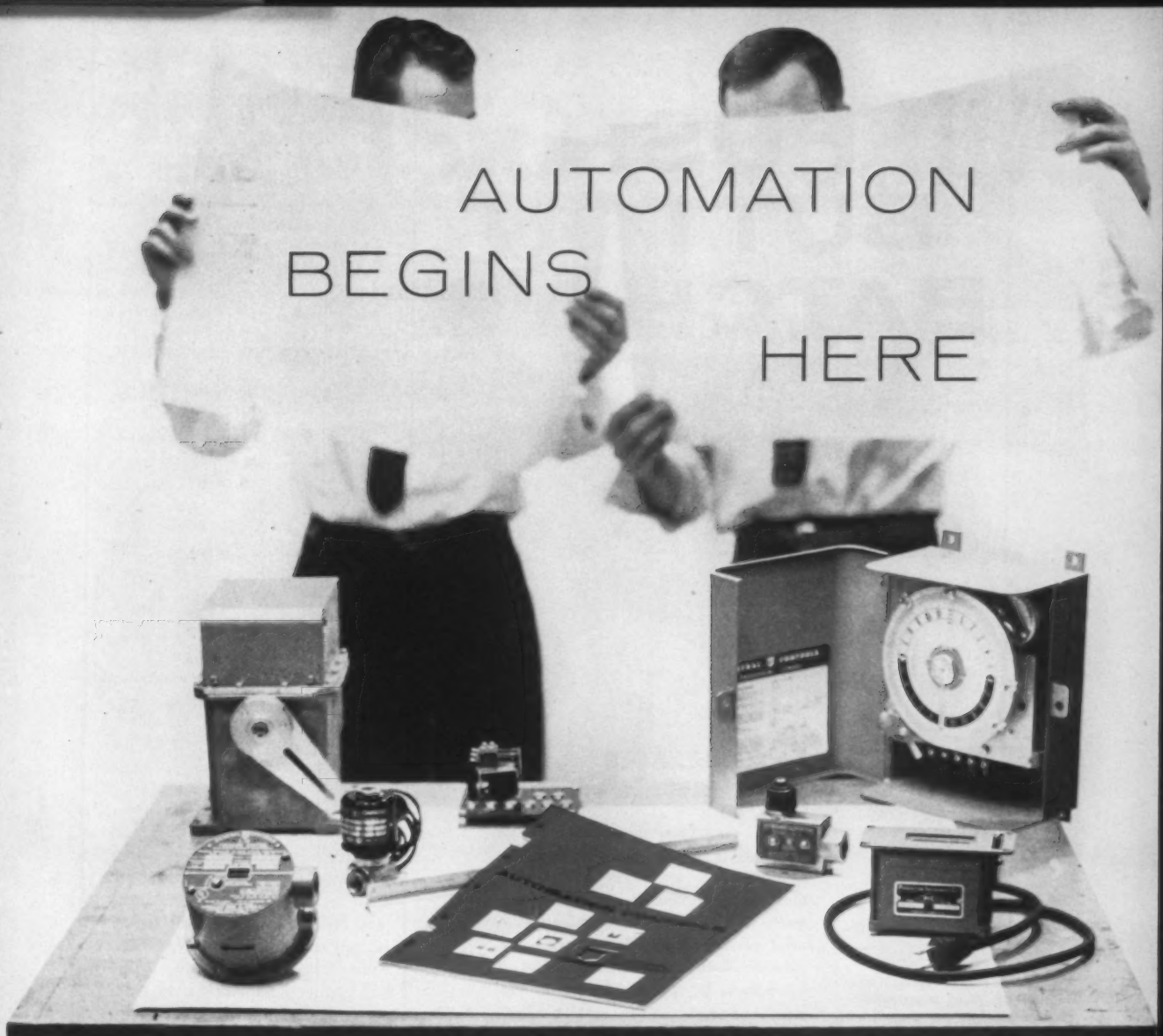

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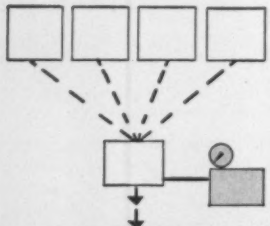

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Union Carbide Nuclear Co.; "Contour Machining As Applied To Jet Engine Parts" by Walter R. Catey, Aircraft Engine Div., Ford Motor Co.; "Job Shop Contour Turning" by R. C. Adler of Dana Mfg. Co.; "The Steel Airframe And Its Machining Ramifications" by Redford C. Rollins of Stanford Research Institute; and "Some Recent Developments In Automatic Programming For Numerical Control Machine Tools" by Douglas T. Ross of the Massachusetts Institute of Technology. This sampling of papers presented in 1957 should whet appetites for the next conference in this series.

Radiometer Shown . . .

Remote temperature measuring device called Thermodot which obtains its information from infrared radiation was demonstrated to west coast engineers recently by Radiation Electronics Corp.

The radiometer is an advanced electro-optical instrument for the remote and passive measurements of thermal (infrared) radiation. The viewing head of the instrument is aimed at a spot on the material where temperature measurements are desired. Spot size is about ½ inch at 10 ft distance. Data for temperature measurement are shown on an indicating meter at an extremely fast response rate. No physical connections whatsoever are made to the specimen being measured.

Engineers viewing the demonstration agreed that the new radiometer would be extremely useful both in research and production work for such uses as controlling the hot forming of all types of materials. Temperature measurements could be made at a distance while the material was actually in the forming dies. Due to its extremely fast response to temperature changes, suggestions were also made to employ the radiometer for fluctuating flame temperature measurements—such as might occur during an explosion—and for measuring temperature fluctuations on parts being subjected to various high speed phenomena.

Ability of this new instrument to act as a control in a closed-loop servo system will undoubtedly find applications in many automated setups where close and accurate temperature control is necessary.

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Circle 673 on Page 127

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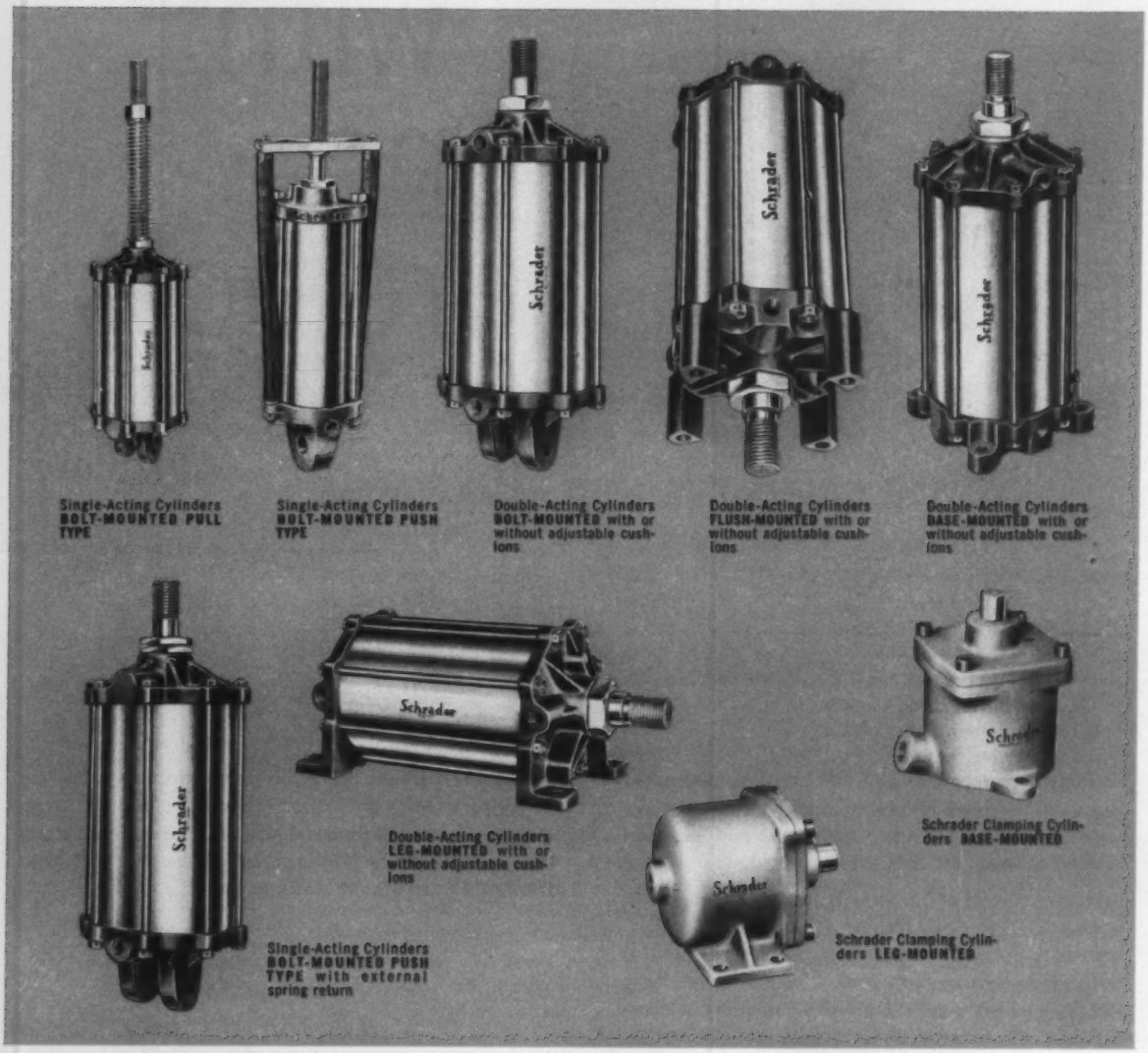
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Circle 674 on Page 127

Hybrids

Considering the variety of unusual new electrical and electronic control devices developed in recent years, it is not unexpected to find many who do not understand why these devices and systems have not displaced all former types used in industry. Without sober reflection, it is all too easy to forget that control is but a single aspect of automation development.

In the "hardware" phase of automation the work performing steps and the handling methods can greatly influence the mode of control used. Additionally, development of the over-all system design having improved production as the outstanding aim, creates another overriding influence not to be overlooked. It would be unrealistic to apply new developments, such as numerical controls, unless cost studies indicate real dollar advantages over conventional modes of control.

It is interesting to observe the trend in industrial management's approach to automation today. New, unusual and relatively unfamiliar control methods are being accepted widely and applied on a large scale—for instance, static controls. Such development work will create a new and continuously expanding area of use and availability.

Needless to say, no one mode of control will offer a panacea for the future. It is the gradual rising level of control accuracy and integration offered by a blending of the old and new that is most significant and valuable.

In a paper presented at the annual meeting of the ASME, Allen Harvey of the Dasol Corp. perhaps summed up the whole practical philosophy most pointedly:

"It is, furthermore, of little meaning that in engineering an automated system, it may prove useful to use old techniques, such as feedback or automatic machines, or new electronic controls and computers. In its systems engineering, automation will use any available technique, old or new, but it will always use it in a new way, in a way that will contribute to the integration and automatic control of a system."

Controls are an important part of the automation picture but industry looks to the manufacturing process engineer for automation systems that pay off. Most often the combination hybrid—as the cover article in this issue shows—will offer the best solution.

EDITOR

AUTOMATIC

FOR

Many different systems are available for automatically weighing bulk materials. In some applications the pneumatic or electric load transducer system can be used to advantage. Basic methods of weighing bulk materials and the application of load transducers are discussed in this article.

By J. C. WILLIAMS JR.,
General Manager
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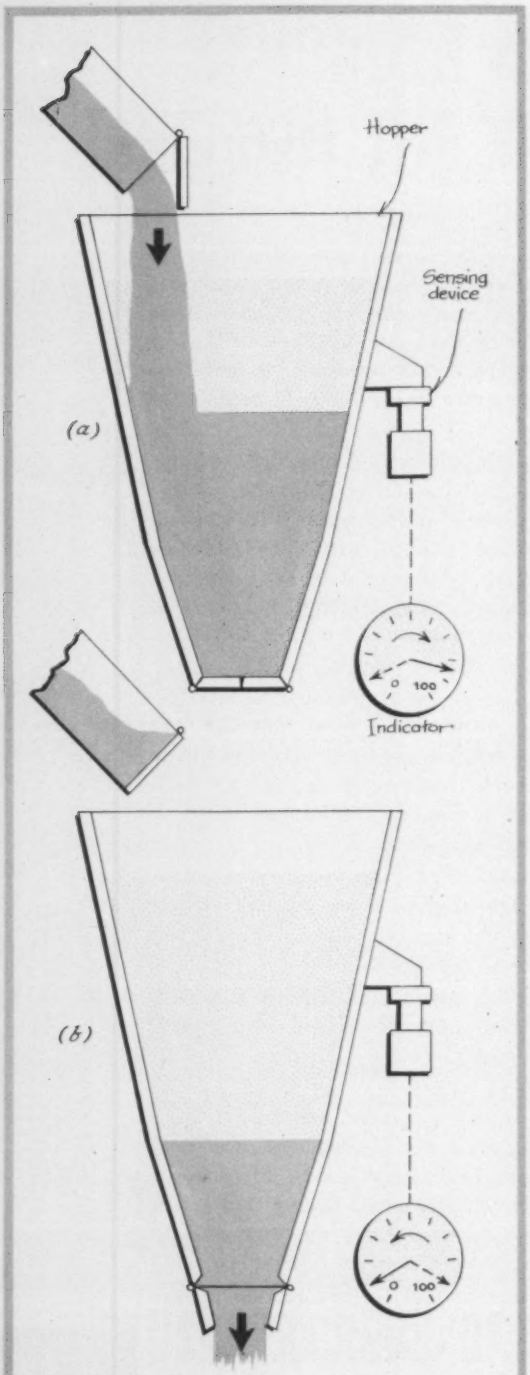


Fig. 1—Batch weighing may be accomplished manually or automatically. Batch-in weighing (a) consists of filling an empty hopper or bin with material until the desired weight is reached, then dumping the load. Batch-out weighing (b) starts with a known weight of material in the hopper, and the material is released until the weight is reduced by the desired amount.

WEIGHTS AND MEASURES ordinarily include those defining length, area, volume, capacity, and mass. Of these, mass is usually recognized as the most important basic measurement, and weight is a force generally equal numerically to mass. Throughout the world, weight is accepted as the universal language of the market place, in the transportation of goods, and in the measure of industrial output. In industry many process formulations are based on weight, especially in the case of handling bulk materials. Cost accounting for bulk materials is usually practiced on a unit weight basis. Packaging of most materials is done on the basis of weight of product rather than volume. As a result, weight measurements are easily understood and converted from one language to another, readily checked, and, like good money, accepted everywhere.

This being the case, industry is actively interested in methods and equipment employed to attain accurate measurement and control of weight. For many centuries mechanical weighing systems employing beam and balance scales were used universally to provide accurate weight measurements. However, in such mechanical scales, accuracy and calibration can be affected by wear of knife-edges, pivots, and bearings which form the working parts of the scale. In certain industries corrosive fumes, moisture, dirt, and dust also create a constant maintenance problem. As the art of bulk materials handling advanced to keep pace with automation of manufacturing processes, mechanical weighing sys-

WEIGHING TECHNIQUES

PROCESSING BULK MATERIALS

tems were equipped with limit switches and photoelectric cells to provide faster and more automatic results. However, these measures were not sufficient to overcome the inherent inertia of mechanical parts which reduced scale response speed and the dynamics of mechanical movements which imposed design limitations. Therefore, instrumental systems were developed to add speed and reliability to automatic weighing to make possible compact weighing packages that could be inserted throughout an automated production line.

Automatic weighing through instrumental techniques was made possible by four developments which added versatility and improved accuracy to weighing. These developments were: 1. Suitable mounting structures to convert eccentric loads to vertical forces for accurate sensing. 2. High fidelity weight sensing devices, incorporating pneumatic or electrical load transducers which require minute deflection for wide range load measurement. 3. Advanced instrumental techniques for indicating, recording, and controlling weight results. 4. Modular construction of delivery, weighing, and removal components which permit maximum interchangeability for changing conditions on the production line.

▶ Basic Methods of Weighing

Two basic methods of weighing are employed by industry—batch weighing and continuous weighing. Both methods may be partially manual, semiautomatic, or automatic depending upon the means employed to feed and remove material from the weighing devices and the type of indicating, recording, or controlling devices used.

BATCH WEIGHING: Method consists of measuring predetermined quantities of material which is cyclically supplied to a process or operation. Batch systems may handle a single ingredient (liquid or solid) or may weigh several different ingredients in a predetermined order or at various points in the process. Cycling, or repetition of the batching operation, may be accomplished manually or automatically.

Batch weighing may be classified into two types of operations—batch-in and batch-out. *Batch-in* weighing starts with an empty hopper or bin which is then filled with material until the hopper attains the desired weight, *Fig. 1a.* The entire hopper is then dumped at one time. *Batch-out* weighing differs from batch-in weighing in that the cycle starts

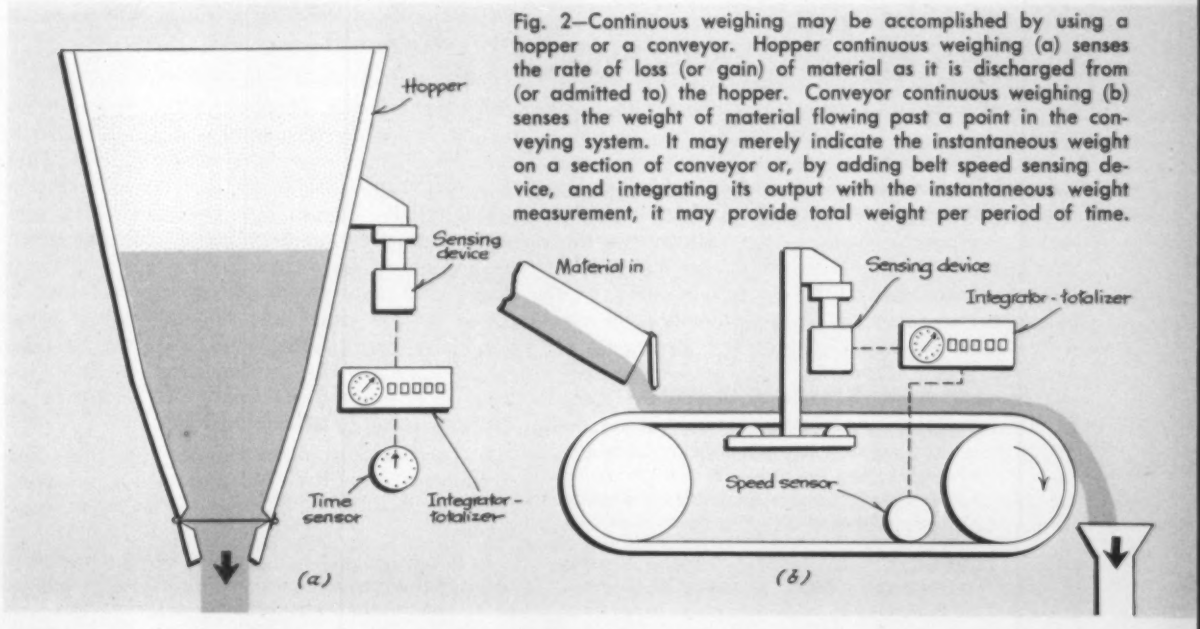


Fig. 2—Continuous weighing may be accomplished by using a hopper or a conveyor. Hopper continuous weighing (a) senses the rate of loss (or gain) of material as it is discharged from (or admitted to) the hopper. Conveyor continuous weighing (b) senses the weight of material flowing past a point in the conveying system. It may merely indicate the instantaneous weight on a section of conveyor or, by adding belt speed sensing device, and integrating its output with the instantaneous weight measurement, it may provide total weight per period of time.

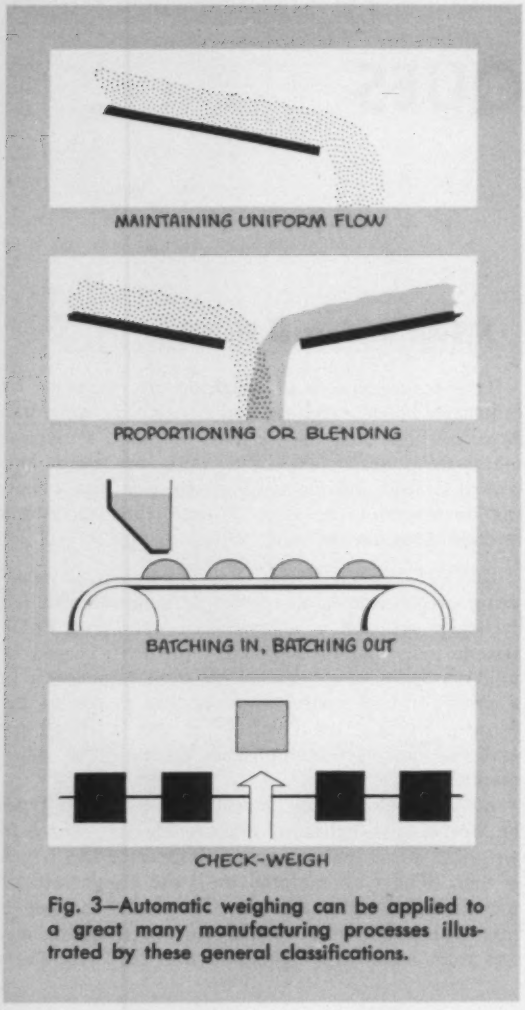


Fig. 3—Automatic weighing can be applied to a great many manufacturing processes illustrated by these general classifications.

with a loaded hopper of known weight. Material is then released from the hopper until the weight has been reduced to equal the desired amount, *Fig.* 1*b*.

Batching systems can be used to weigh out one material in an exact predetermined proportion to another material, the amount of which may be varied. An example would be the addition of a softening agent to containers holding varying quantities of plastic material. The proportioning type batch system would add varying quantities of softening agent to each container in a fixed ratio of agent to plastic. Other types of batching systems can be used to weigh out a predetermined quantity of material at fixed time intervals or on demand from a process. This differs from continuous weighing in that material is intermittently weighed and released rather than being weighed as part of a continuous flow.

CONTINUOUS WEIGHING: Method involves a weight measurement taken as material or product flows or is conveyed from one point to another. When only an instantaneous weight reading is taken, it indicates the weight of material in the measuring section at that instant. However, if this measurement is integrated with time measurements when the flow speed is constant or with the flow speed itself when it is variable, a total weight for any given period can be obtained.

Continuous weighing may be classified into two types of operation—hopper or conveyor. *Hopper* continuous weighing is based on sensing the rate of loss (or gain) in the weight of material as it is discharged from (or admitted to) a hopper, bin, or other container, *Fig.* 2*a*. *Conveyor* continuous weighing is accomplished by sensing the weight of a material as it is moving past a point in a conveying system. Total flow per period of time may be determined by integrating the instantaneous weight measurement with the conveyor speed, *Fig.* 2*b*.

▶ Automatic Weighing

Automatic weighing of liquids or solids combines batch or continuous weighing with control techniques to accomplish one or more of the following operations, *Fig.* 3: 1. Maintain a uniform rate of material flow in process. 2. Batch a predetermined weight of material in or out. 3. Proportion, blend, or mix materials. 4. Check-weigh units.

Automatic weighing may be a single automatic platform scale or an extensive system consisting of receiving, conveying, feeding, valving, weighing, and dispensing devices. It may begin at the receiving dock for raw materials, continue through various processes of manufacture or conversion, and end in a container complete with counting and shipping records on the shipping dock. Such extensive systems can be composed of many combinations of weighing and control components shown in *Fig.* 4.

In order to provide accuracy and versatility in automatic weighing systems, three basic elements, *Fig.* 5, are necessary:

1. *Suitable structure* correctly applies weight to a load sensing device. Design of this structure is important because sensing devices can be affected by nonaxial components of force applied to them. Thus, they can respond to forces that do not represent actual weight. Nonaxial or horizontal force components can be introduced in weighing by eccentric loading of the weighing vessel. Only in exceptional cases will a perfectly symmetrical load be poised at the center-line of the sensing device. Therefore, the weighing structure must be properly designed to resolve the entire weight of the material to be measured into a single force for accurate detection by the sensing device.

2. *Load sensing device* receives the single force component of the load and translates it into pneumatic or electrical signals proportional to the weight applied.

3. *Receiving device*, remotely located, responds to the signal from the load sensing device to indicate or record results. The same signal from the sens-

ing device can be used to initiate control command units.

Automatic weighing systems may be mechanical, pneumatic, hydraulic, electrical, or a combination of these. Pneumatic and electrical systems are especially versatile and offer unlimited combinations of components.

▶ Load Sensing Devices

The load sensing devices are the heart of weighing systems, and three broad considerations are involved in their selection.

Accuracy: Since process materials are costly, sensing accuracy can easily pay for itself many times by reducing weighing errors by a few tenths of a per cent. Highest reproducible accuracy of signal is therefore an obvious requirement. Linearity of signal, fast response to rapid weight changes, and freedom from ambient effects are necessary characteristics.

Ruggedness: Because the sensing device is in the actual material handling area, it must be sturdily constructed to withstand rough treatment without requiring frequent maintenance. It must endure shocks and vibration. It must be dustproof and

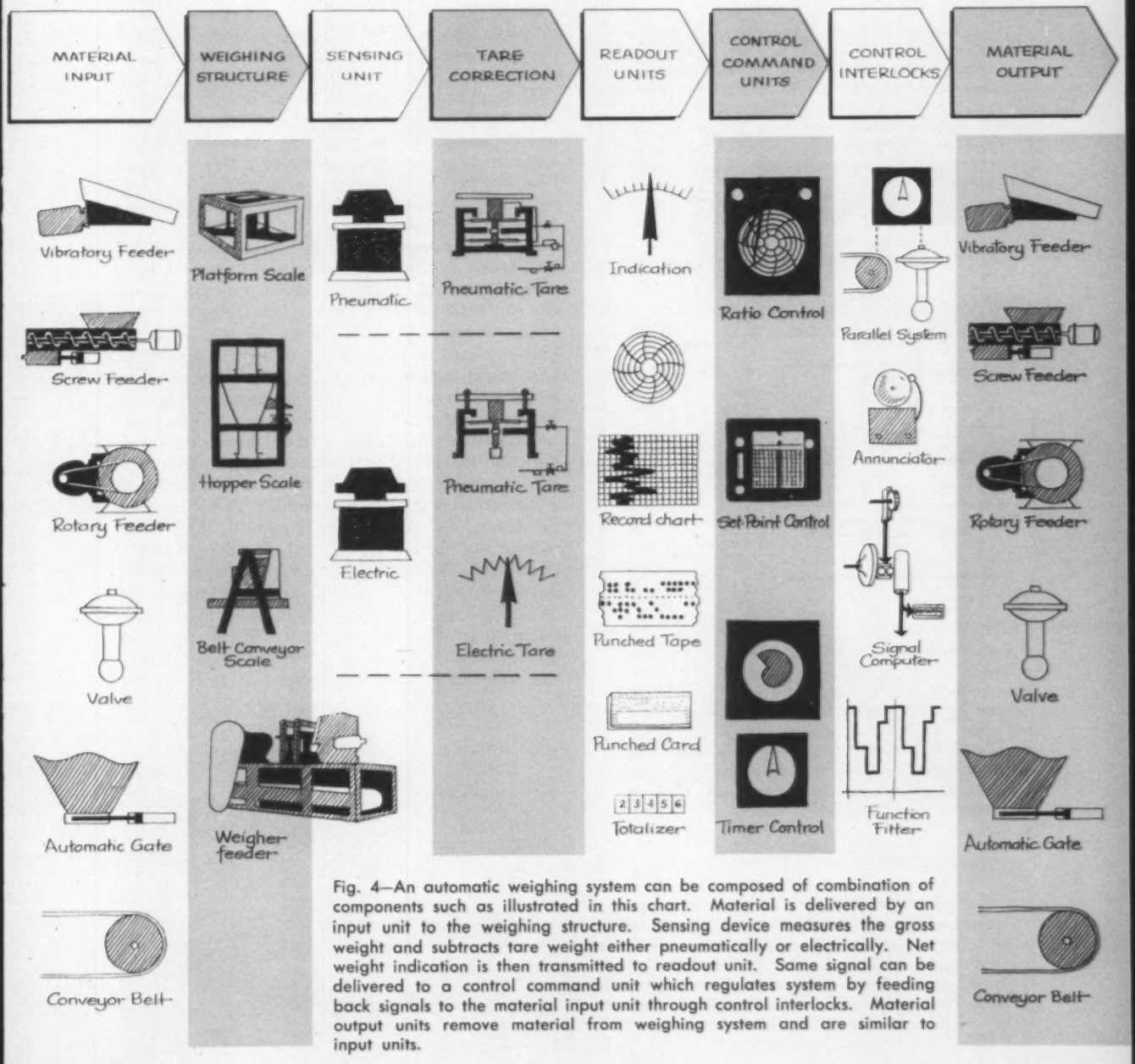


Fig. 4—An automatic weighing system can be composed of combination of components such as illustrated in this chart. Material is delivered by an input unit to the weighing structure. Sensing device measures the gross weight and subtracts tare weight either pneumatically or electrically. Net weight indication is then transmitted to readout unit. Same signal can be delivered to a control command unit which regulates system by feeding back signals to the material input unit through control interlocks. Material output units remove material from weighing system and are similar to input units.

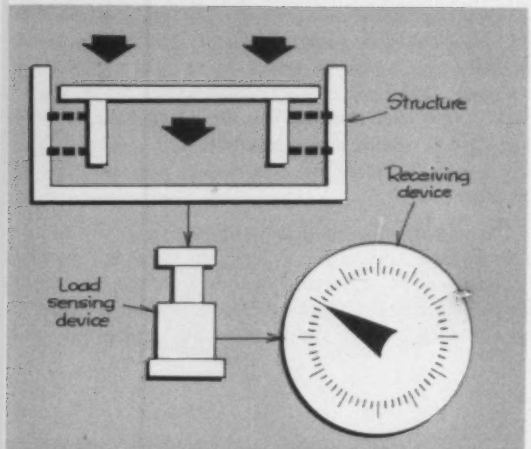


Fig. 5—Basic elements of an instrumental weighing system are a suitable structure to translate eccentric load into a single vertical load component, a load transducer to convert vertical force into a pneumatic or electrical signal, and a remotely located receiving device to indicate or record the net weight. Same signal can perform several control functions in the system.

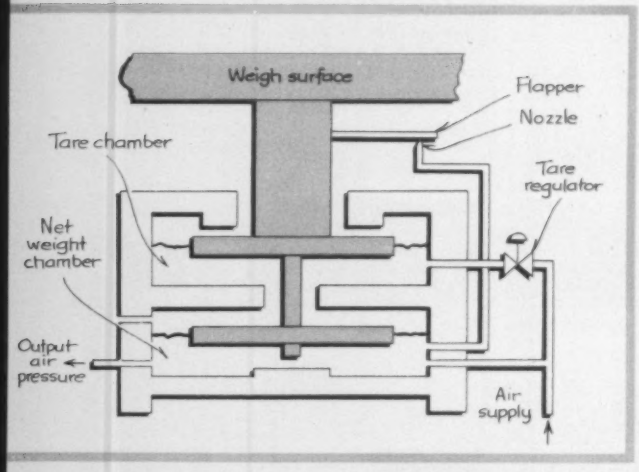


Fig. 6—Pneumatic weight transducer uses a tare chamber to nullify weight of platform and container. Application of weight on platform forces flapper down on nozzle which is bleeding air from net weight chamber in bottom of device. Nozzle opening is reduced by flapper and air pressure in net weight chamber rises. When pressure balances the weight, it is a measure of net weight on platform and is used to operate readout and control devices.

Fig. 7—Platform scale consists of a pneumatic load transducer mounted in a rigid frame and supported by flexure bars. An integral pulse damper acts as a shock absorber, permitting the scale to withstand vibratory and impact loads without affecting calibration. Scale is accurate to within 0.25 per cent of calibrated weight range. Total operating movement is only 0.005 to 0.008 inch

moistureproof. It must resist corrosive fumes. In certain situations, it must be explosionproof or nonelectrical. Over-range protection must be provided.

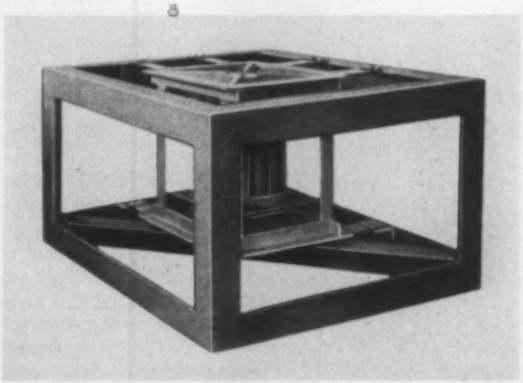
Flexibility: Because of processing changes and plant growth, adjustability and unit construction are desirable. Tare adjustment is invariably required. Suitability of signal for actuating a number of receiving devices is needed to permit maximum utilization.

Pneumatic and electrical transducers are commonly used as sensing devices in weighing systems. The pneumatic transducer has an inherently simple design and provides positive explosion-proof construction. Since all pneumatic systems can provide the standard ISA range of 3-15 psig, wide flexibility in the selection of instrument components is attained. Pneumatic systems are usually characterized by lower service or maintenance requirements.

Electrical transducers offer advantages where multiple transducers are required, or where extremely long-distance transmission is necessary. They also provide greater flexibility where computer or data-logging functions are required. In some cases, the final element—the valve, gate, variable speed drive, etc.—may be the major determining factor as to which system is preferred.

A typical pneumatic weight transducer is shown in *Fig.* 6. It operates on a force-balance (null) principle, providing fast, accurate response. There are two internal air chambers, one being the net-weight chamber, and the other, the tare chamber. Each is closed on one side by a flexible diaphragm. Diaphragm-type construction requires no pivots and levers and thus hysteresis effects are minimized and friction effects are eliminated.

Compressed air is fed to the net-weight chamber and bleeds to atmosphere through a nozzle. When weight or force is applied to the platform, a flapper or plug regulates the flow of air through the nozzle. As more weight is applied, the flapper reduces the nozzle opening, and air pressure in the chamber increases. When this pressure multiplied by the effective area of the diaphragm equals the weight on the platform, a state of equilibrium is established. When the weight is reduced, the bleed nozzle opens to reduce pressure and again balance the unit. Since chamber pressure is a measurement



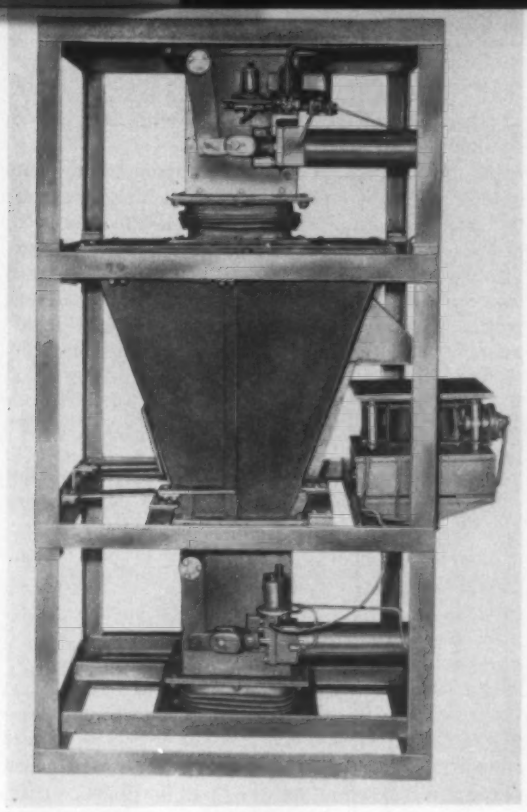
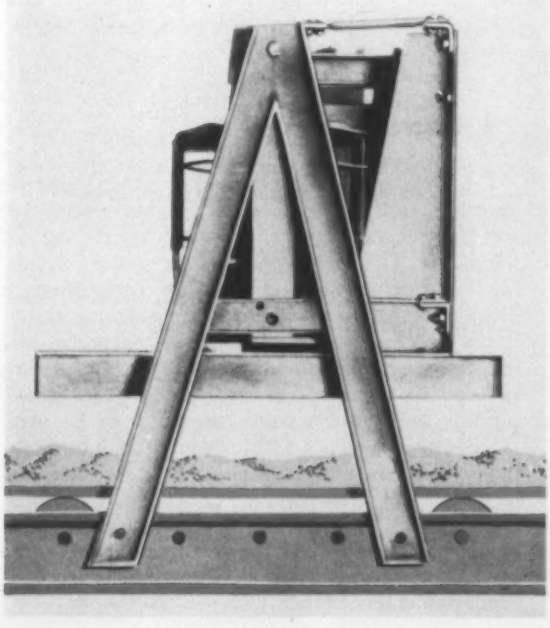


Fig. 8—Hopper scale uses a basic hopper frame which can be adapted to a variety of input and output controls. Weight of material in hopper is transmitted by triangle-shaped bracket to load transducer at right center.

Fig. 9—Belt conveyor scale continuously weighs material in transport. Frame support (a) carrying conveyor transmits weight of loaded belt to pneumatic transducer which is supported on rigid horizontal crosspiece. When used in conjunction with electrical speed transmitter (b) and the two-function integrator (c), the rate of flow of materials in terms of weight can be indicated, recorded, totalized, controlled, proportioned, or programmed.



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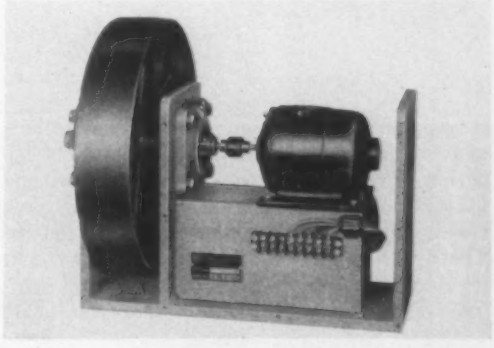

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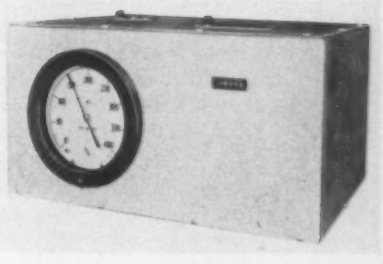


(c)

of weight, it is transmitted to operate the indicating, recording and controlling devices to which it is connected. Usually the tare chamber is supplied with a fixed air pressure to counterbalance the fixed weight of tank, hopper and other equipment, so that only net weight is measured.

The weight range of a given unit is determined by the air pressure supplied and the effective diaphragm area. Normal operation requires a pressure supply of 50 psig. The range of a certain size unit may be approximately doubled by using two net-weight chambers. Additional tare chambers may be used when high fixed weights are involved.

▶ Types of Scales

Application of basic weighing elements to weighing equipment for handling bulk materials involves specialized engineering. Many combinations and techniques are possible, but this discussion will be limited to types of equipment most commonly used in industry. These can be classified as platform scales, hopper scales, belt conveyor scales, and belt and screw weigher-feeders.

Platform scales: These are the simplest basic units used in applications of automatic weighing, *Fig.* 7. They may be applied to existing vessels and are readily engineered into new systems. The scale structure provides a rigid weighing platform on which the load may be eccentrically located without losing weighing accuracy. By using proper sensing devices, movement of the platform can be extremely small for the entire weight range of the scale.

Hopper scales: These are one of the most frequently used pieces of bulk materials weighing equipment, *Fig.* 8. A building-block type of ar-

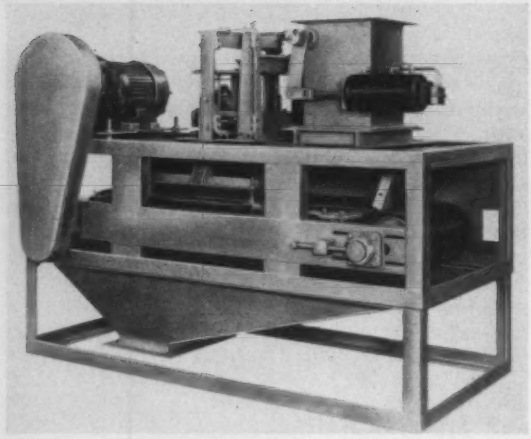
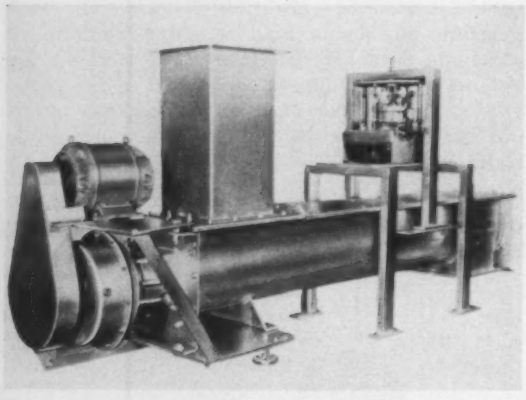


Fig. 10—Belt weigher-feeder (above) is a complete unit in itself. It contains a belt conveyor scale operating from a self-contained conveyor belt. Material enters gate feeder in upper frame, drops to conveyor for weighing, and leaves system through chute in lower frame. This same principle of weighing is applied to the screw weigher-feeder (below) Here, the conveyor belt has been replaced by a screw. Entire mechanism of this unit is "tared out" as it floats on scale supported by four columns at center of unit. Material enters top of vertical hopper at left and is discharged from bottom opening at right.



rangement can permit one hopper frame to be used with different types of material input and output devices. In this way, standard equipment may be selected to best fit a materials handling problem and to provide flexibility for change in the future. The upper building-block can contain the material input devices for controlling the feed of material into the hopper. The middle unit can hold the weighing assembly consisting of the hopper and sensing device. This unit is isolated from other units by flexible accordion sections. The lower building-block can contain material output devices for controlling the discharge of materials from the hopper. It may be an exact duplicate of the upper unit or may differ as application requirements dictate.

Belt conveyor scales: These are used to continuously weigh material which is being transported, *Fig.* 9. Belt conveyor scale units can be installed on either existing or proposed conveyor systems, whether flat-belt or trough-type, with little modification to the system.

By the addition of unitized components, the rate of flow of the material in terms of weight can be indicated, recorded, totalized, controlled, proportioned or programmed. The unit employed for indicating and totalizing weight on a variable-speed conveyor incorporates a two-function integrator which integrates the instantaneous weight measurement with the conveyor speed to obtain the rate of flow. The conveyor belt speed is transmitted to the unit either mechanically by a belt drive or electrically through a pair of selsyn-type motors. In the case of a fixed-speed conveyor, the rate of material flow is integrated by using a synchronous timing motor instead of a selsyn to read out the total flow.

Weigher-feeder scales: These units are complete weighing-conveyor systems and may be either belt or screw type as in *Fig.* 10. The belt weigher-feeder measuring unit is a complete conveyor section equipped with a belt conveyor scale for the necessary weight range. The weighing pan rides against the under surface of the material-loaded portion of the belt. The pan is suspended from the vertical supporting structure so that, regardless of uneven pile-ups of material on the belt, a single vertical component of weight can be delivered to a pneumatic weight transmitter.

The screw weigher-feeder is similar to the belt weigher-feeder except the material transport unit is a screw feeder. This unit is an example of a weighing scale where the tare weight of the unit greatly exceeds the net weight of material being weighed. However, by proper design and installation, this unit can perform with as great an accuracy as the other devices discussed.

In general, the control action of a weighing system involving a weigher-feeder is to maintain a uniform rate of flow. However, like the conveyor belt scale, the weigher-feeder may also be equipped with a flow totalizer, recorder, programmer, or proportioning arrangement in conjunction with parallel systems.

General Considerations

The weighing scale or weighing system takes on countless variations when modern instrumentation and control devices are activated by the weight transducer. The control panel of the system containing the instruments and electrical components is usually located remotely from the weighing installation. In this way it is protected from abuse and free from contaminating atmospheres, dust, or dirt. In explosive atmospheres predominantly pneumatic controls in explosion-proof housings can be used.

Substantial benefits, such as minimized labor costs, increased production, higher quality of product, and more efficient and accurate packaging, have been the dividends that industry has obtained by employing automatic weighing systems. Invariably, the installation of such systems returns handsome dividends on the invested capital.

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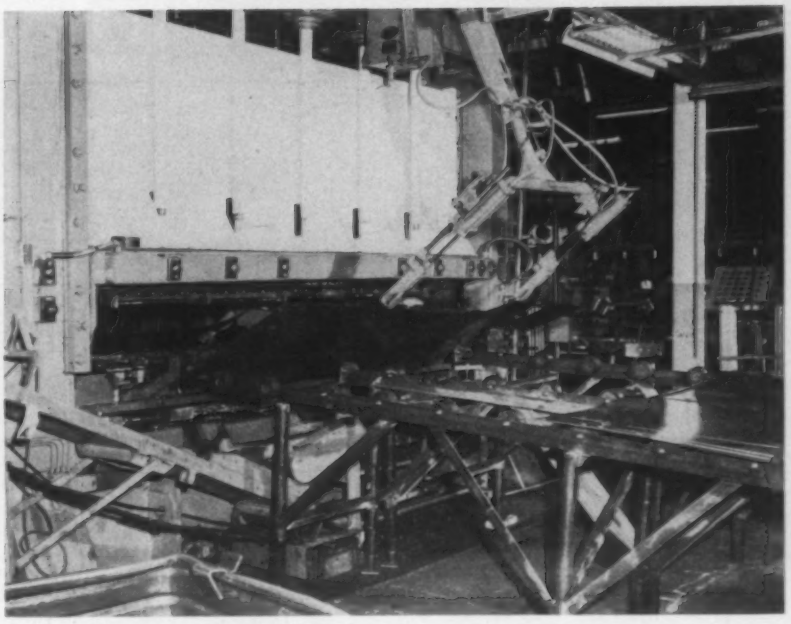


Steel sheet for a wraparound shell which will become a washer cabinet is of 18-gage cold-rolled enameling steel measuring 37½ by 107 inches. After being passed through a roller leveler, the sheets are fed from a roller table into the first of three Verson presses that are joined to form a production line by means of gravity roller conveyors. Sheets are manually loaded into the presses. The first and second press in the line are unloaded by Sahlin Iron Hands in the manner illustrated by this picture of the back of the second press. The scrap trimmed off in this press falls on conveyors that deposit it in tote bins.

AUTOMATION TODAY

HANDLING DEVICES SPEED

WASHER CABINET PRODUCTION

By **EDWARD DAMSCHRODER,** Tool Engineer, Clyde Div., Whirlpool Corp., Clyde, Ohio

IMPORTANCE of handling to automated operations is dramatically illustrated where the workpieces are large and obviously difficult to manhandle. As dramatic to the production engineer concerned with large items are the cost savings and increased production which result when handling devices enable standard automatic equipment to operate more in conformity with inherent capabilities.

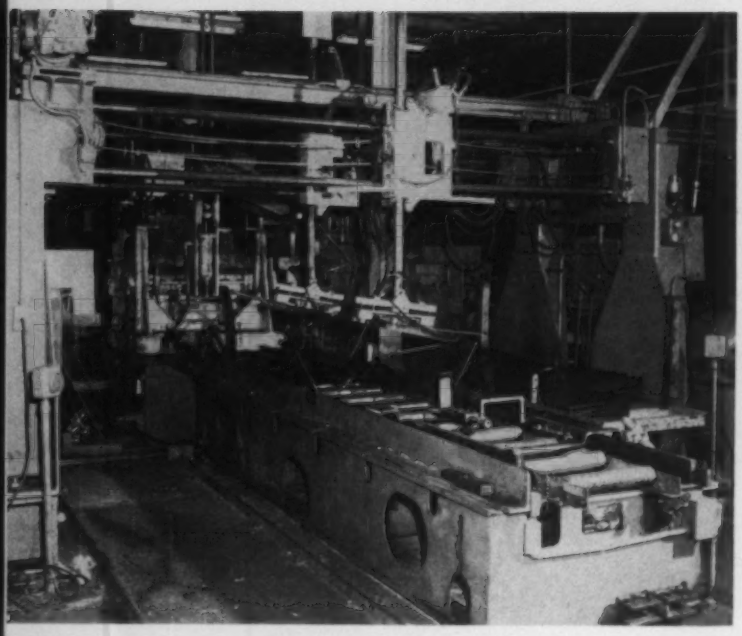
In the major appliance field, the Whirlpool Corp. has been particularly active in seeking and planning for improved productivity through the use of handling devices which link standard machines into a production line.* This approach has enabled the company to progressively develop improved facilities in digestible doses as handling equipment is made available. A portion of the line at the Clyde Division devoted to the manufacture of metal cabinets for washing machines illustrates some of the ways handling devices are being used to develop an automated production line.

The production process involves large single sheets of 18-gage cold rolled enameling steel which pass through various blanking, trimming, forming, and welding operations—ending up as a cabinet ready for an enamel finishing.

The press portion of the line includes three Verson presses and roller rail installations for movement of work between presses. Parts are loaded manually and unloaded by Sahlin Iron Hands, except for the last press which is unloaded manually.

Blanks from the press area are next processed through a Struthers Wells tangent bender which is automatically loaded and unloaded. An initial welding operation with a Federal spot welder, which completes the joint established as the blank is formed into a rectangular form, occurs before the

* "Sheet Handling Devices," AUTOMATION, Vol. 5, No. 5, May 1958, pp. 89-90.



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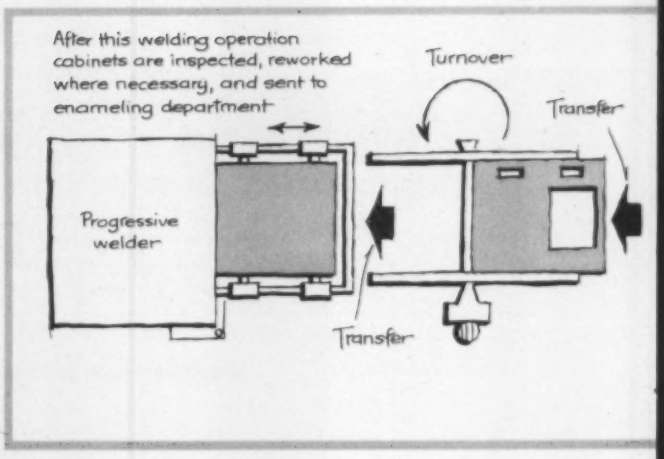
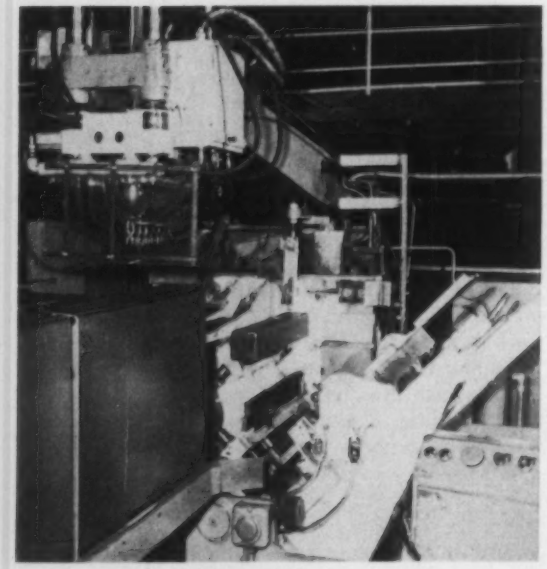
As blanks leave the third press in the line, they are loaded onto a special rack for transfer to the tangent bender area. The rack is spotted beside the illustrated automatic unloading and feeding setup for the Struthers Wells tangent bender. Racks can be placed at either side of the unloader which has a double-arm pick-up device arranged to slide transversely along a bridge track above the feeding unit. Each vertical arm of the unloader has two rubber suction cups on a hinged support that can tilt to accommodate itself to the stacked angle or position of the flanged blanks to be picked up. The vertical arms are moved up or down by rack and pinion. Blanks are picked from the stack and deposited on the automatic feeder in a shuttle operation that is repeated until the load is exhausted. In the meantime, another rack of blanks from the flanging press is spotted at the other side of the tangent bender feeder, ready to be unloaded in a similar manner.

part is ejected from the tangent bender.

Subsequently, the cabinet moves through a series of three Progressive spot welders in which gusset plates, brackets, and other reinforcements are added. Transfer between welders is automatic. After this welding line, the cabinets are advanced to the finishing department where synthetic enamel is applied. However, cabinets that receive porcelain enamel must undergo much higher heating than those with synthetic enamel. To prevent warpage at high temperatures, prior to enameling these cabinets are sent through a supplementary manual welding line where extra reinforcements are welded in place.

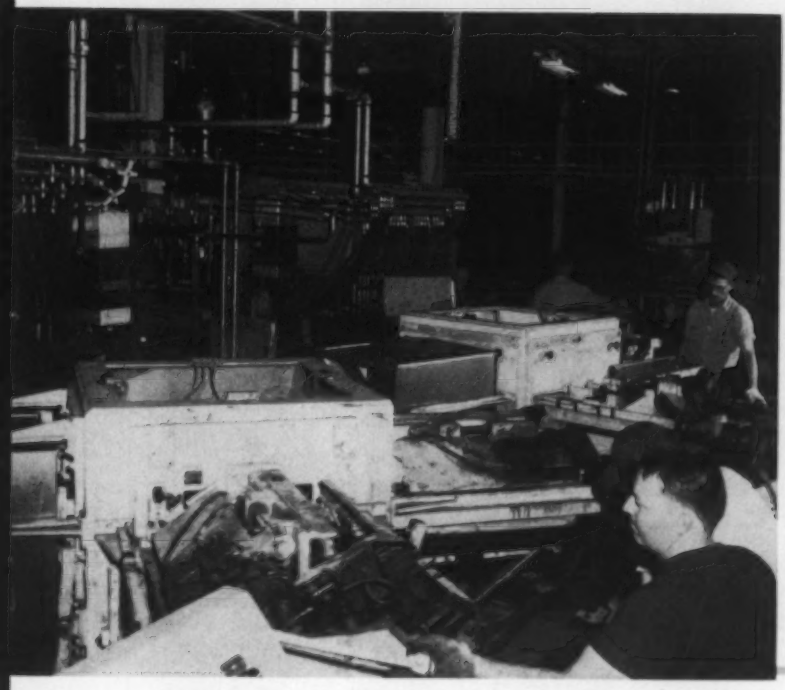
Accompanying photos show details of a portion of this washer cabinet production facility.


After this welding operation cabinets are inspected, reworked where necessary, and sent to enameling department
Turnover
Transfer
Progressive welder
Transfer



3

Each blank placed on the tangent bender loader is moved at the proper time into the bender. The blank is gripped and the loading carriage is withdrawn. Subsequently, the bender forms the blank around its dies, making four bends and producing a rectangular wrap-around automatically. This results in an overlap of edges of the wraparound below a Federal spot welder whose upper electrodes are rocked down to make 12 spot welds along the joint and then are rocked back to clear the work. After the dies of the bender unlock, the cabinet is unloaded from the bender automatically. An average output of this bending-welding operation is approximately 165 wraparounds an hour.



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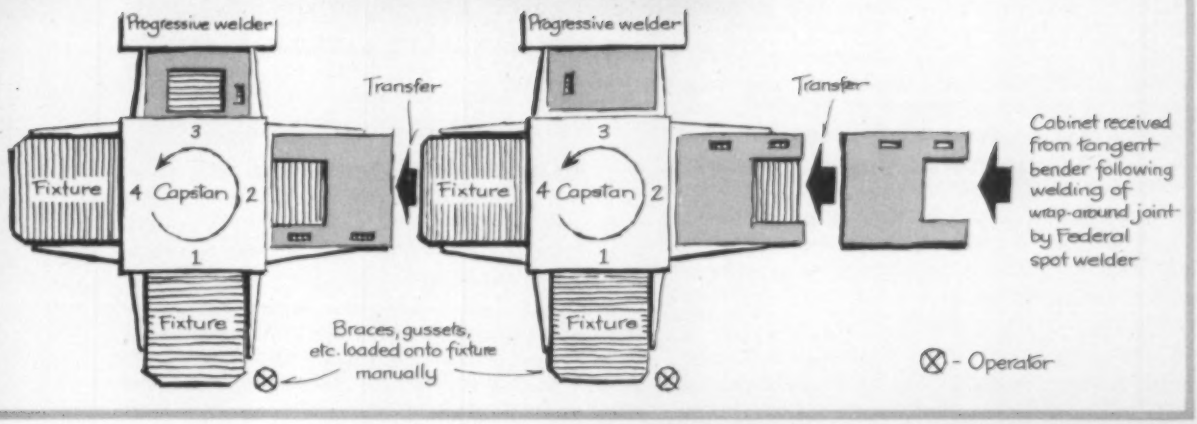
Following the forming of the cabinet in the tangent bender, various gussets and braces are spot welded to the cabinet. For these welding operations, the line includes three Progressive welders. The first two welders are presented work by four-fixture capstan devices capable of successively indexing through 90 degrees or four stations, and the third is provided with a shuttle-type fixture. At one station at each of the capstan welders, operators load brackets, braces and other components onto a fixture. As the wraparound is ejected from the tangent bender, it is automatically loaded onto a fixture at the second station of the first capstan device. The welding of braces to the cabinet occurs at the third station and automatic transfer of the work from a fixture occurs at the fourth station. The second capstan device is synchronized with the first and is automatically loaded as a cabinet is stripped from a fixture on the first. Upon indexing through the welding cycle and to the unload station, cabinets from the second capstan are automatically transferred to a handling device that links the second and third welder in the line.



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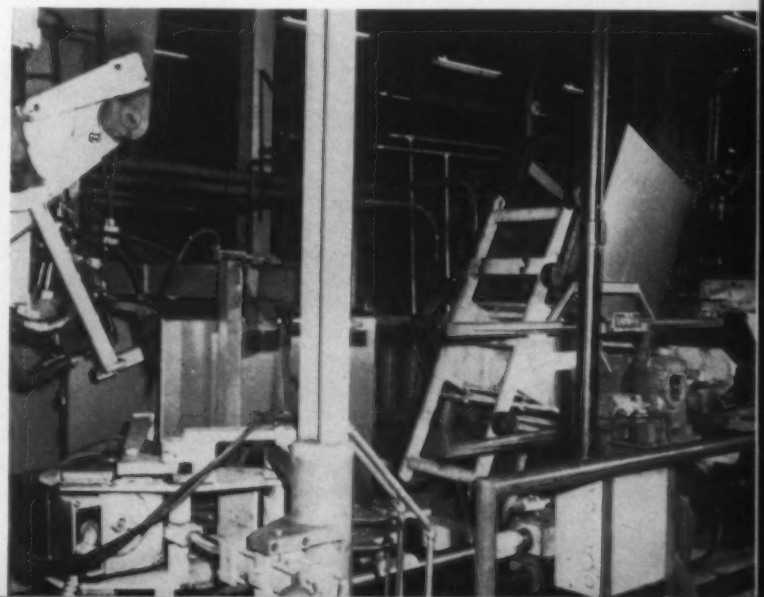
Welding operations in the two capstan welders are performed with the back of the washer cabinet uppermost. As the cabinet is unloaded from the second welder, it is automatically transferred into a turnover device that rotates through 180 degrees to shift the cabinet end for end. With the front of the cabinet uppermost, it is loaded into welding position at the third Progressive welder by a shuttle-type fixture for completion of the welding operations. A total of 127 spot welds are placed by the three welders, with the only manual operations being the loading of braces and other reinforcements into the various fixtures.



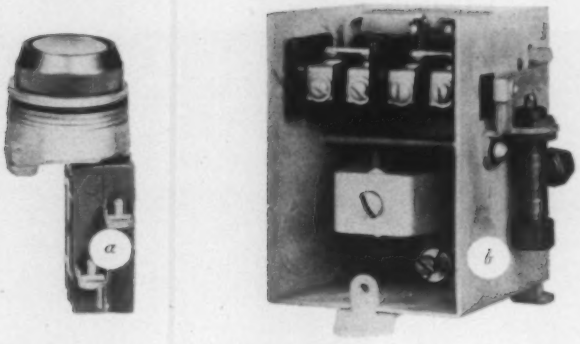


Fig. 1—Some of the available pilot devices for introducing information into an electrical control system include: (a) pushbuttons, (b) pressure switches, (c) limit switches, and (d) plugging switches. Pilot devices usually close or open a set of contacts in an electrical circuit that includes other control devices.

BASIC ELECTRICAL CONTROLS

Most industrial plants in the United States cannot operate without using basic electrical controls. Such controls include three broad types of devices — pilot, logic, and power — mounted in suitable enclosures. The author discusses basic components for systems and presents diagrams illustrating solutions to universal problems such as motor starting and stopping.

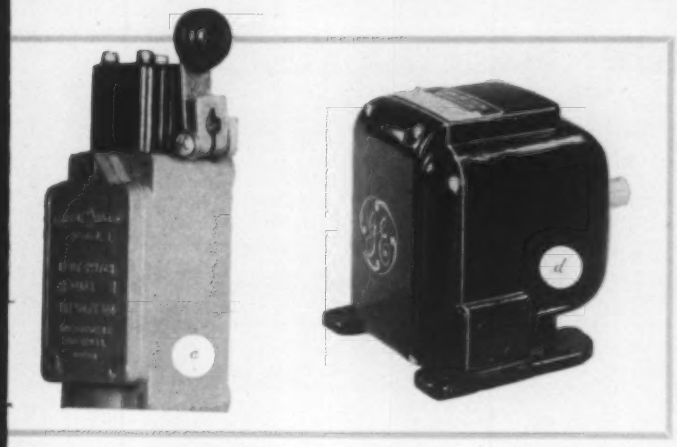
By **JAMES C. ELDER**, Design Engineer, General Purpose Control Dept., General Electric Co., Bloomington, Ill.

A LOOK in the control panels of new machine tools or the control panel of one of Detroit's latest transfer machines will show that a majority of the devices are standard components produced by electrical control manufacturers. This is not to say that the electrical industry has not taken note of the requirements for various industries and supplied special devices where needed. For instance, the basic control relay which is used in a transfer machine panel must be reliable, must have long life, and must be flexible in the number of poles or combinations of poles that can be provided. Most electrical manufacturers have met this need with a small versatile relay which can be provided in any combination of poles up to 12. In refinery applications control components may be exposed to an explosive atmosphere, and motor starters have been developed which are of an oil immersed explosion-proof type.

In any of these applications the control systems are made up of as many components as are necessary to do the job. Of course, each of these applications has its peculiarities and special components which are required for their control. In general, however, there are only three types of control devices—pilot devices, logic devices, and power devices. These types of devices perform three functions: The pilot function of providing information, the logic function of making the decision based on this information, and the power function of controlling work as required by a decision.

Pilot Devices

A pilot device translates some physical quantity—temperature, pressure, distance, or force—into action in an electrical circuit, usually as the closing or opening of a set of contacts. These pilot devices, *Fig.* 1, must have enough capacity to carry and interrupt the current of the coil with which they are being used, plus being able to make on the inrush current of the coil. When the coil of a relay or magnetic switch is first energized, a large current flows which is limited mostly by the coil resistance. The coil reactance is almost negligible when the coil is first energized. After the magnet operates the switch, the current flow (magnetizing current) is then limited mostly by the coil reactance which has become quite high. The ratio of inrush to mag-



netizing current is large, on the order of 10 to 1 or 20 to 1 depending on the design of the magnet. Difficulty may be experienced because of the inability of a pilot device to take the inrush current required for closing of a large magnetic switch. The pilot device is then allowed to operate a relay with smaller inrush, and this relay can then have the capacity to operate the larger device.

Pushbutton switches, *Fig. 1a*, are the most widely used pilot devices and may be mounted in their own enclosures or in the cover of a panel. There are three main types or classes of pushbuttons—standard-duty, heavy-duty, and oiltight. The type of pushbutton used depends on the application. Standard-duty pushbuttons are used for light and medium duty where the inrush rating of the contactor coils will not exceed the ratings of standard pushbuttons. Heavy-duty pushbuttons are constructed for applications of severe or frequent duty and have heavier contacts and construction with approximately twice the rating of standard units. Oiltight heavy-duty pushbuttons are constructed to prevent entry of oil, liquids or dust around the button or operator. They are used on machine tool panels and many other applications because of their versatility. Oiltight units are made from building blocks consisting of operators, colored rings, and electrical contact blocks. The operator variations include several kinds of heads—standard, mushroom, coin operated, extra-long, dustproof, etc. Because of the variety of operators, color rings, and number of contact blocks an enormous number of combinations is possible.

Oiltight pushbutton blocks can also be used with other operators as selector switches. The most commonly used selector switch is the three position *Hand-Off-Automatic* form which allows the operator to close the circuit in the hand position, open it in the off position, or control it by an automatic pilot device in the automatic position. By changing the cams and number of blocks many varieties of selector switches can be made. Locking cylinders are also available. More recently an illuminated oiltight pushbutton has come on the market. This combines an oiltight indicating light in a transparent pushbutton operator and has the advantage of saving the space normally needed for a light.

Pressure switches, *Fig. 1b*, are very commonly used pilot devices. One type opens or closes electrical contact by mechanical operation from a diaphragm. The diaphragm is operated by pressure of a liquid or gas and can be set to open or close the contacts at the pressures desired. Pressure switches are available in a wide range of operating pressures from nearly zero to several thousand pounds per square inch with both small and large differentials available. In selecting a pressure switch one should be sure that the contacts have snap action or follow through without any tendency to flutter with small fluctuations in pressure at the time the switch is to operate. Flutter of the contacts will result in excessive stops and starts of the motor or machinery and excessive tip wear on the magnetic contactor. This condition can be remedied by adding a timer to the circuit to delay operation of the circuit until the pressure has reached stability. Where differential pressure is very small, as in filling an open tank with liquid, it may be preferable to use a float switch. Since its operation depends on a float riding up or down with the level of the liquid, more accurate control of the liquid level may be obtained.

The limit switch, *Fig. 1c*, is another widely used pilot device, by which movement of an element is

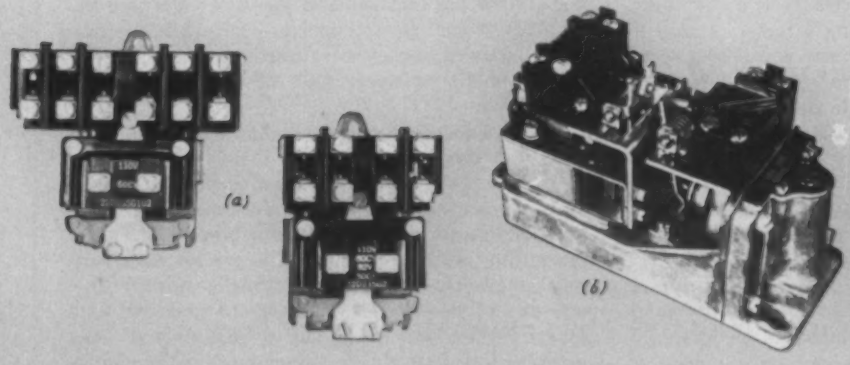


Fig. 2—Logic devices to act on the information from the pilot devices include: (a) standard relays and (b) time delay relays. The logic devices perform a decision-making function to bring about a predetermined action when the pilot devices report certain conditions.

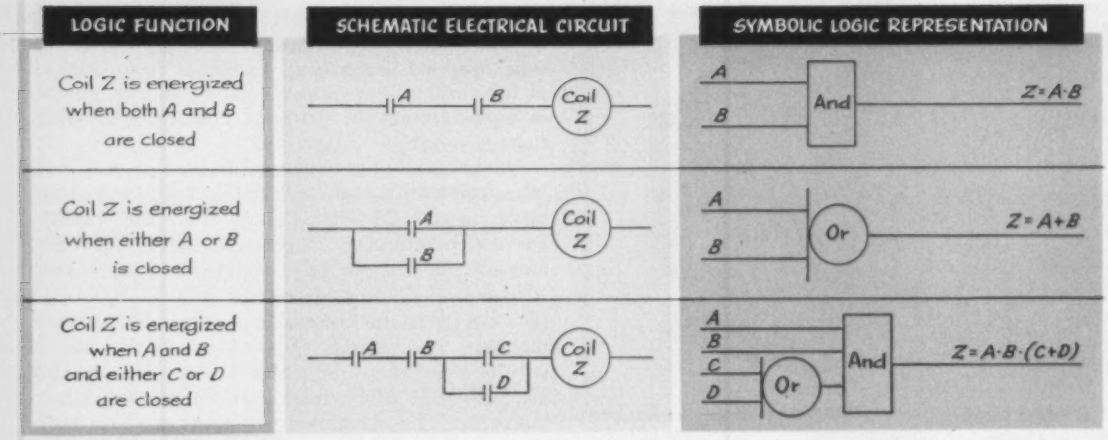


Fig. 3—Typical electrical circuits and their symbolic logic representations indicate relationships of pilot device contacts A, B, C, or D to operating coil Z of the logic device, which in this case may be a standard relay. Condition of circuit to coil Z thus determines condition of contacts of the logic device which are located in other circuits.

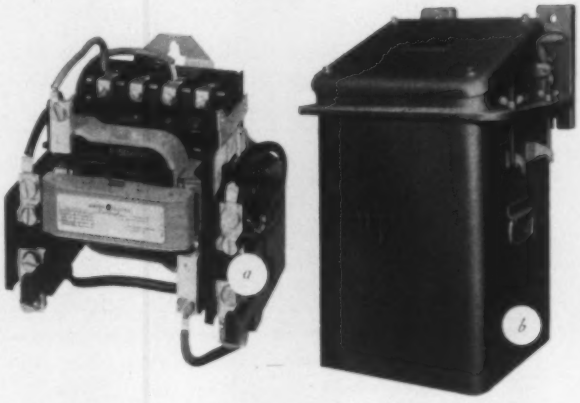


Fig. 4—Power devices which may be controlled by the logic device include: (a) standard magnetic switches and (b) oil-immersed magnetic switches. The standard magnetic switch shown is typically used for controlling the power to a 3-phase motor and incorporates overload protection on two of the lines to the motor. The oil-immersed switch shown includes a manual circuit breaker in an explosion-proof design.

used to make or break electrical contacts. For convenience of wiring, the limit switch is usually mounted on the stationary part of the machine and is actuated by the movement of some other part of the machine. Limit switches are made in a wide variety of sizes and types of construction for the many applications. Various types of actuating elements are used such as plungers, rollers, or forks. Also, rotating type limit switches are operated by rotating cams or cams on shafts and are used to operate electrical circuits at certain angular positions of a shaft. Limit switches are available with maintained contact or spring return action where the contacts open as soon as the force is removed from the trip lever. Limit switches are made in standard or heavy-duty units and have normally-open and normally-closed contacts usually in single-pole construction, although multiple poles are available in certain types. Since limit switches are mounted on machinery where oil or coolant is present, National Electrical Manufacturers Association (NEMA) oiltight enclosures are commonly provided.

Plugging and antiplugging switches are centrifugal switches which can be connected to a motor shaft. Plugging is a means of bringing a motor quickly to a stop by applying reverse power until zero speed is reached. The plugging switch, *Fig. 1d*, has one or two sets of normally open contacts which are closed when the motor is operating, but which open when the motor approaches zero speed. These contacts are used to open the coil of the motor starter and disconnect the power from the motor as motor speed approaches zero. This prevents restarting in reverse when zero speed is reached. Plugging switches may also be used as devices to indicate or interlock the operation of remotely located rotating units. They are used to interlock sections of a conveyor in order to prevent jams on a section of conveyor if a succeeding section stops. This is necessary in large automated warehouses where all control is at a central point. Antiplugging switches are used where it is desired to reverse a motor but not until it has reached zero speed. In this case the normally closed contacts remain open while the motor is at speed and close at nearly zero speed. The closing of the contacts then allows the motor to be reversed.

Program timers are almost unlimited in their variations of number of circuits, length of time and special features for special applications. These switches are usually electrically driven but may have additional spring operated drives. They allow pre-setting or programming of a process on almost any length of cycle, but are usually limited to a one day cycle. However, timers are available with longer cycles including day omission and even astronomical dials which compensate for the change

in length of the day, although this is not usually necessary in industry.

Logic Devices

The basic device in the logic or decision-making part of a machine control is the control relay. This relay is available with 2 to 12 poles in almost any combination of normally open or normally closed contacts, *Fig. 2a*. Since the circuitry used in a panel for a large machine is rather complex, it is very desirable that logic relays have a long, trouble-free life. Downtime is very expensive on large process or transfer machinery, and the manufacturer is very sensitive about shutting down due to failure of a simple relay. The relay consists of a magnet and coil assembly which physically closes the contacts when the coil is energized. The contacts on the relay are usually rated 10 amp carry, 60 amp inrush, and 60 amp interruption.

The most commonly used time-delay relay is the pneumatic timer, *Fig. 2b*, which has a solenoid-operated, pneumatic-piston-controlled timing head. The time-delay relay contains electrical contacts operated by the shaft movement of a pneumatic piston. The movement of the piston is regulated by the amount of air allowed to flow through a small adjustable orifice. The time delay can usually be adjusted from 0.1 to 180 seconds by adjusting the screw controlling the orifice. The timers are available in time delay on energization or on de-energization. In addition to the time-delay electrical contacts, instantaneous contacts actuated by the solenoid are available. The units have an accuracy of plus or minus 10 per cent. Motor operated timers are also available for uses which require greater accuracy, although they are considered to have shorter life.

There may be times in an operation when it is necessary to remember whether a certain operation has occurred. This memory function can be accomplished using a latched-in relay. This is a relay that is provided with a latch to hold it closed after it has been energized. The relay is provided with a solenoid which will unlatch the relay when power is applied to its coil to void the memory.

Using these three basic relays, the decision-making function of the control panel can be accomplished. Most control circuits consist of several pilot contacts in a circuit with the coil of a relay as shown in *Fig. 3*. If the pilot contacts are in parallel, the coil will be energized when either set of contacts is closed. If the pilot contacts are in series, the coil will be energized only when both sets of contacts are closed. By varying the circuit with arrangements of series and parallel contacts, almost any set of conditions can be controlled. In each case, however, the decision-making relay is making a decision based on information furnished by the pilot devices. This information is then sent to the power handling contactor which allows power to flow to the motor or other work-performing component. At times it may be desirable to delay action based on a decision. This can be done by using a time-delay relay in place of the standard relay. The delay may also be used to see that the pilot devices still indicate the same decision after a time interval.

Power Devices

The basic power control device is called a magnetic switch or contactor. This consists of a solenoid or electromagnet which is mechanically connected to a set of power contacts. Energization of the coil of the electromagnet moves the armature and the movable contacts mechanically held to it in a direction to close against stationary contacts. The contacts are mechanically held closed by the flow of current through the coil. Removal of voltage allows the contactor to open. NEMA requirements specify

ELECTRICAL CONTROL DEVICES

Pilot Devices

Pilot or sensing devices control other devices whose contacts actuate the coil circuit of a magnetic switch or relay. The pilot devices may be operated by hand or may be automatically operated by some variable such as pressure, temperature, flow, distance or direction. The pilot device can be part of a control panel as in the case of a pushbutton, time switch or pressure switch; or it may be located remotely at some part of a machine or plant. For instance, a thermostat is usually located near the point at which the temperature is being taken; limit switches are located on the machine where they can be mechanically operated; and a pushbutton will be located for the convenience of the operator, not necessarily where the panel is located. Pilot devices vary in complexity from a pushbutton to the highly accurate instruments used in process control.

Logic Devices

With the advent of static control units in the control industry, engineers have become more aware that the logic or decision-making function has been performed by interlock circuits using standard relays. This function can be performed in the control circuit using three basic components—the control relay, the delay relay, and the memory or latched-in relay. Combinations of these devices are used in a control panel to make decisions based on the information given by the pilot devices.

Power Devices

The basic device which controls power is called a magnetic switch and is merely a switch which is usually closed magnetically and opened when the magnet is de-energized. A magnet coil is energized to close the switch and electrical power then flows to the motor or other electrical devices through the switch. The magnetic switch is usually enclosed in a metal container to protect the operator and other personnel from the live electrical parts. Several magnetic switches and other devices may be grouped together in a packaged control system for a group of motors or a complete industrial process. This is usually done for easy maintenance and for easy accessibility in troubleshooting.

that the contactor close on 85 per cent of rated voltage and operate satisfactorily on 110 per cent of rated voltage without overheating. The contactor will remain closed on voltage drops to approximately 50 per cent of rated voltage depending on the design of the magnet. This is an important fact to note in an automated type of operation, because a voltage drop of this order of only one half cycle duration can drop out a magnetic switch and perhaps shut down part of an operation.

In some situations it is desirable to make certain that a contactor will not reclose itself on return of voltage after an undervoltage occurrence. Such undervoltage protection is accomplished by using a normally open set of contacts on the contactor in series with the voltage supply to the coil. If the voltage drops enough for the contactor to drop out and then full voltage is later applied, the contactor will not automatically close. This is important because if an operator started to work on a machine after a voltage failure and the power came on again, the machine could start with the return of voltage and injure the operator. Although power failures are becoming increasingly rare, this can be a safety hazard in a plant.

On the other hand, in certain areas where momentary voltage drops are experienced rather frequently, much valuable production time can be lost and jams occur if part of a process or an automated line shuts down. If these voltage drops occur and undervoltage protection is necessary, then the most practical solution is time-delay undervoltage protection. This is provided by a unit with a time-delay circuit which will delay the opening of the coil circuit of a contactor for a period of usually two seconds after an undervoltage occurrence. This requires more than a simple timer since the contactor must open immediately if the stop button is pressed but must reclose after a power failure if power is returned within two seconds.

Overload protection is offered by a device referred to as a magnetic starter or an across-the-line starter, *Fig.* 4. A general-purpose three-phase motor can be started most easily and efficiently by connecting it directly to the three-phase line. This results in faster acceleration with less heating of the motor windings than is accomplished with other types of starting. The across-the-line starter usually consists of a three-pole magnetic switch and overload relays in two of the motor leads. NEMA has established standard current and horsepower ratings for across-the-line starters, TABLE 1. The size of the starter is designated by numbers and the maximum horsepower ratings are shown. The current carrying parts of the starter must have thermal capacity to operate at the currents shown for 8 hours without exceeding the temperature limits set up by Underwriters Laboratory. A contactor will have reached a stable temperature after eight hours of operation and this rating can be considered continuous. This rating is for a starter mounted in the open, and the starter is considered to have 90 per cent of this rating when in an enclosure where ventilation is cut off and the ambient is higher. The higher temperature in an enclosure also means

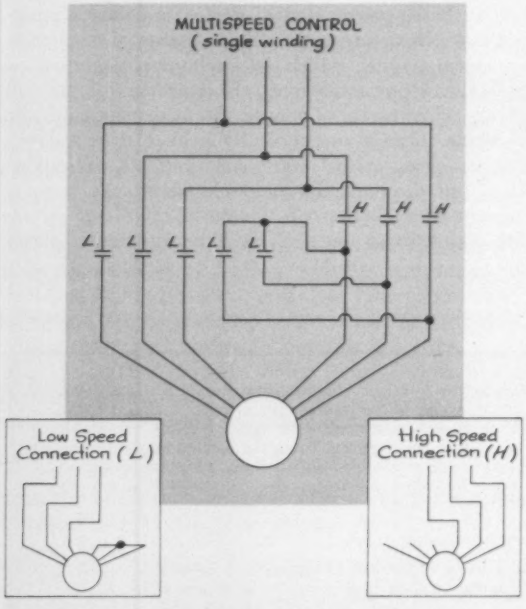


Fig. 5—Circuit illustrates application of power devices to provide two speeds from an ac motor.

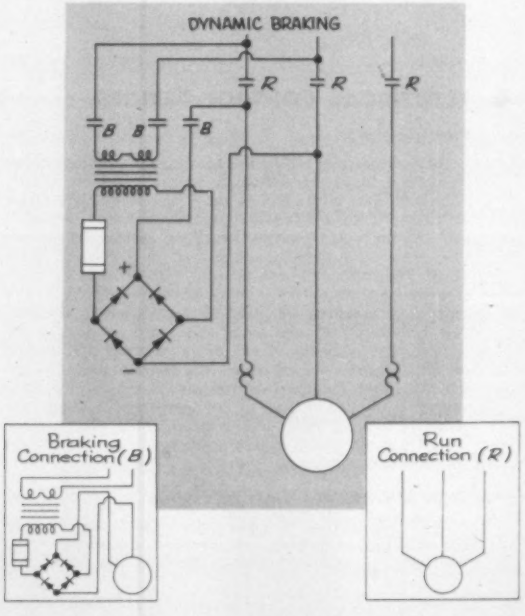


Fig. 6—Use of power devices in another frequent industrial application is illustrated by this circuit for dc dynamic braking of an ac motor.

that a given overload relay will trip at a lower current in an enclosure than outside. The starter must also be able to close and open on the maximum motor current. This maximum current occurs when full voltage is applied to the motor before the rotor starts to turn. NEMA standards limit the maximum current to six times the full load current of the motor. The normal interruption current would be full load current unless the motor has been mechanically stalled.

Overload relays are provided with replaceable heaters to allow adjustments in approximately 10 per cent steps by changing heaters. The tables provided are usually for 40C rise motors which have

TABLE 1
NEMA HORSEPOWER RATINGS OF ACROSS THE LINE MAGNETIC STARTERS

Starter Size	8-hour open rating amps	NON PLUGGING DUTY 3 phase horsepower at 110v	220v	440-550v	PLUG-STOP OR JOGGING DUTY 3 phase horsepower at 110v	220v	440-550v
00	10	¾	1	1	⅓	½	½
0	15	2	3	5	¾	1	1
1	30	3	7½	10	2	3	5
2	50	7½	15	25	5	10	15
3	100	15	30	50	10	20	30
4	150	25	50	100	15	30	60
5	300		100	200		75	150
6	600		200	400		150	300
7*	900		300	600			
8*	1350		450	900			
9*	2500		1800	3600			

* Non plugging type only

a service factor of 1.15 and can operate with a 15 per cent overload. The overload relay heater will allow overloads of from 115 to 125 per cent of full load before tripping. Other types of motors with high temperature insulation for 50 and 55C rise do not usually have a service factor over one and provision must be made to select a heater which will trip at the full load current.

The starter is not designed to interrupt short circuit current due to a fault in the motor circuit. For this reason a disconnect switch and fuses or a circuit breaker should be provided to interrupt short-circuit current of the motor or branch circuit. In addition, this provides a disconnecting means to allow work to be done on the starter. Underwriters specify that the maximum size of fuse should not be more than four times the full load current of the motor. Tables are published for recommended size of fuses or breakers for the various methods of starting.

Speed Changing

Speed changing of an induction motor can be accomplished by two methods. The first requires the use of a special wound-rotor motor which has the armature leads brought out through slip rings on the shaft. Speed control is obtained by inserting resistance in the rotor circuit. The speed depends on the amount of rotor circuit resistance and the load applied to the motor. At no load very little if any speed reduction is accomplished by inserting resistance, but under load the speed can be reduced by increasing the resistance. When the external resistance is zero the motor has nearly the same characteristics as an induction motor.

The second method of varying the speed of a motor is to change the number of poles of the motor by changing the power connections, such as decreasing the speed to one half by changing from two to four poles. Two-speed motors are most common, but many three or four-speed motors are built. They are used on fans and blowers and on machine tools to allow changing speed rapidly, and are more economical than wound rotor motors. There are two types of connections generally used on two-speed motors. One type provides two windings one of which is energized for each speed. On a three-phase motor this requires two 3-pole contactors mechanically interlocked so that only one can be closed at a time. The other type of connection uses a single winding which is reconnected to change speed, *Fig.* 5. This requires a three-pole contactor for one speed and a five-pole for the other. The extra two poles are required to connect three of the leads together. Mechanical interlocking is necessary to prevent a short circuit from occurring when the three leads used for the first speed are shorted together on the second speed. Either single winding or two-winding multispeed motors may be constant torque, variable torque or constant horsepower. NEMA allows a lower horsepower capacity for constant horsepower motor starters than for standard motors. This lower NEMA rating is required because of the high running current drawn by the motor at low speed.

Motor Stopping

The time required for a machine to come to a stop before a part can be removed may become an appreciable factor in the machine time for a part. If this can be cut down by braking the machine to a stop, a major saving may be accomplished. Dynamic braking is an effective means of accomplishing this rapidly and automatically. This method applies dc power to a motor winding after ac power has been removed. Since the frequency of the applied voltage is zero, the rotor tries to change to zero speed also. The rate of braking depends on the amount of dc current applied. At least three times full load current is required to brake the motor to a stop in the time required to start it. A typical circuit diagram for dynamic braking is shown in *Fig.* 6. The braking panel requires a resistor or transformer to reduce

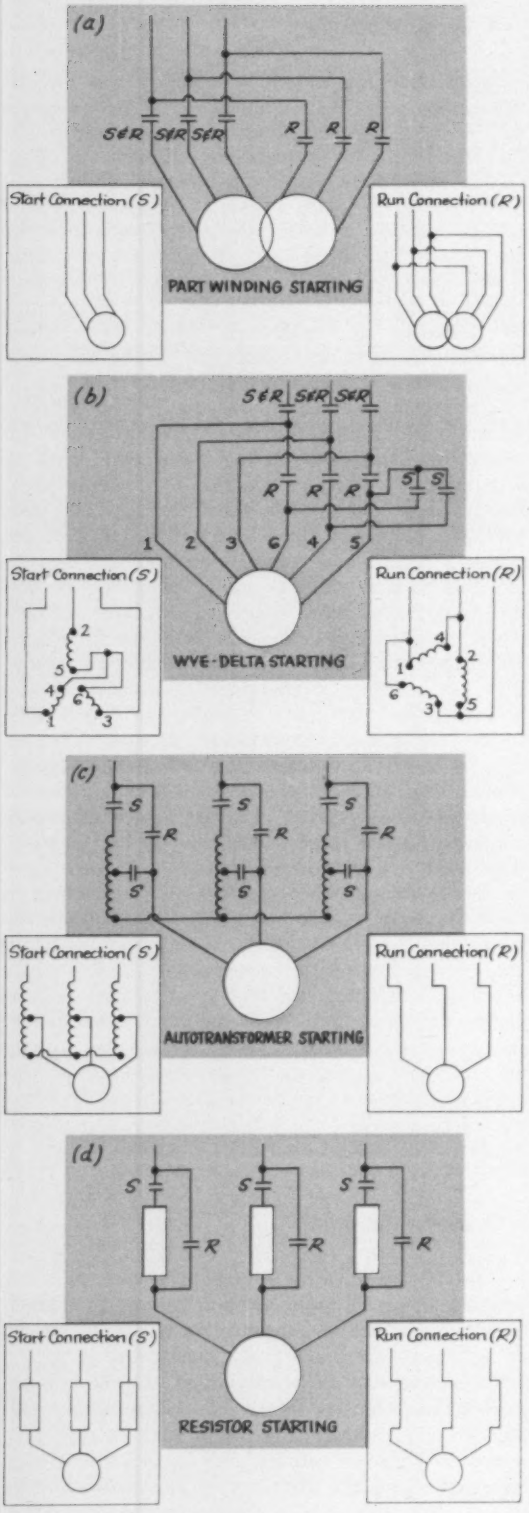


Fig. 7—Solutions to the problem of starting motors without excessive starting loads on the power system include: (a) part winding starting, (b) wye-delta starting, (c) autotransformer starting, and (d) resistor starting.

the voltage to a value, usually on the order of 100 volts, that will produce the required current. A pilot device is also required to remove the dc power when the motor has stopped.

As mentioned previously, plugging is another means of stopping a motor rapidly. For this a reversing contactor is required and the three-phase motor is stopped by reversing two of the input power leads when the reversing contactor is closed. Although the length of time that the reversing voltage is applied may be controlled with a timer, this is usually not considered satisfactory because of the small elapsed time the motor is at zero speed before reversing. For this reason a plugging switch is normally used to remove power when zero speed is reached.

A timer is satisfactory in dynamic braking because the motor can only reach zero speed and the time of removal of power is not critical. The severity of the plugging action can be reduced by applying reduced voltage to the motor during plugging. In this way the deceleration rate can be varied. Because of the high current (approximately 1.2 times the locked rotor value) drawn when the power is reversed while the motor is running at full speed, NEMA has derated contactors for this type of duty. TABLE I shows the NEMA ratings for starters used for plugging duty.

▶ Motor Starting

The objective with any method of starting is to connect the motor across the line, but direct across the line starting at full voltage can in some cases produce objectionable results. If the supply system does not have capacity to meet the full voltage current requirements, the line disturbance can be severe. The largest motor in a plant, which may be the air conditioner, may cause a computer to shut down because of the drop in line voltage with full-voltage starting. For this reason, power companies may limit the size of motor which can be started on full voltage. This is especially true when the motor or motors are located at the end of long feeders.

To reduce the inrush current of a standard induction motor requires that some means be provided to reconnect the motor windings or provide a reduced voltage supply for starting. These methods of starting have been classified as reduced-voltage starting. The starters first connect to the line in a manner suitable for reduction of inrush current, and after a time delay the motor is connected directly across the line, *Fig.* 7.

Part winding starting is now most commonly used on air conditioning installations where the starting torque requirements are low. This method consists of connecting part of the winding on the first step and then after a time delay connecting the remaining windings to the line, *Fig.* 7*a*. The inrush current of this method is approx. 60 to 70 per cent of full voltage starting current. It will produce approximately 40 to 45 per cent of full voltage starting torque but with a rather severe torque dip at one-half speed. This torque dip is

most severe when one-half of the winding is first connected. If two-thirds of the winding is connected initially the torque dip will be less severe. Part winding starting can be used to start standard 220/440-volt reconnectable motors on 220 volts, but a special 440-volt motor with two windings is necessary for 440-volt part winding starting. Additional steps of starting can be provided by adding steps of resistance to the starter. This is a closed transition method of starting since there is no interruption in the flow of current to the motor during starting. It is the least expensive method of reduced-voltage starting because it requires only a timing device and two starters each rated at one half of the load.

Wye-delta starting is another method of reconnecting the motor during starting to reduce the inrush current. It requires a delta-wound motor which has the six ends of the windings brought out. For starting, the motor winding is connected in wye, *Fig. 7b*, which reduces the inrush and torque to 33 per cent of that in full-voltage starting. The motor windings are connected in delta for running which puts full voltage across each winding. This method gives a high torque for the current drawn from the line. However, this torque is only one-third of full starting torque and is not adjustable. These restrictions explain why this method of starting has never gained the popularity in the United States that it has in Europe.

Autotransformer starting is the most widely used form of reduced-voltage starting and is commonly called the compensator method. During starting the motor is connected to taps on the autotransformer which is itself usually wye-connected across the line, *Fig. 7c*. Standard autotransformers have 50, 65 and 80 per cent taps furnished so that adjustment in starting torque or current can be made. Starting on the 65 per cent tap, the line current drawn will be 42 per cent of full voltage inrush current of the motor and the motor will give 42 per cent of full voltage starting torque. Adjustment can be made by changing to the 80 per cent tap to increase the torque to 64 per cent of full-voltage torque. If lower starting current is desired a change to the 50 per cent tap will change the starting current to 25 per cent of full-voltage starting current. No special motor is required since only three connecting leads are required. The autotransformer type starter offers a higher starting torque per ampere drawn from the line than any other adjustable reduced-voltage starter and can be used with any standard motor.

The resistor starter is another method of reducing inrush current and torque. It consists of inserting resistors in series with the motor leads during starting, and shorting out the resistors after a time interval when the motor has nearly reached full speed, *Fig. 7d*. The torque efficiency of the resistor starter is less than that of an autotransformer starter. With a resistor starter which limits the starting current to 65 per cent of full-voltage starting current, the torque will be 42 per cent of full-voltage starting torque. The resistor starter has some compensation for its low initial starting torque in that, since the current decreases during starting, the voltage drop across the resistors is less and the voltage across the motor increases giving better acceleration. Also because resistors are used, the power factor during starting is higher than with other methods. During starting the resistors absorb a large amount of power depending on what per cent voltage is applied to the motor. This energy is given off as heat which must be dissipated. Resistor starters are excellent for applications where a reduction in starting torque is desired for a process or machine. In the smaller sizes, resistor starters are less expensive than autotransformer starters.

Reactor starters are similar to resistor starters but use reactors in place of the resistors. This method doesn't have the advantage of the better starting power factor but does have the advantage of not needing a ventilated enclosure such as required by a resistor starter to dissipate heat. Reactor starters are used in place of resistor starters on high voltage applications since it is easier to provide high voltage insulation on a reactor than on a resistor. Reactor starters can be used on almost any application where resistor starting is acceptable.

Enclosures

The selection of the proper enclosure for a simple starter or a large panel is important in an application if reliable operation is to be obtained. Although the NEMA Type 1 general purpose enclosure is the most commonly used, many applications require special types of enclosures. For instance, dust-tight enclosures may be necessary for a cement mill where the dust is not hazardous, while an NEMA 9 enclosure is required in a flour mill. NEMA 12 enclosures are generally used in the automotive industry to protect against oil and dirt. The use of these special types of enclosures can mean the difference between satisfactory operation and costly shutdowns. NEMA standards list enclosure types and their general descriptions. In addition, large enclosures which group the motor starters for a large number of motors are becoming more popular. In this type of control center, each motor starter has its own compartment with an access door for easy maintenance.

Conclusion

Electrical controls include three types of components—pilot devices, logic devices, and power devices. The pilot devices are the sensing elements. The logic devices act as the decision-making elements and may be required to remember what has gone on in making the decision. The power devices control the work-producing energy supplied to the motors. Proper combinations of these elements in satisfactory enclosures provide reliable industrial control. Automation requires the combining of these units into a system which will control the complex machines which are producing the products of industry today.

CO-ORDINATED HYDRAULIC DRIVES POWER LAMINATING MACHINE

VARIABLE delivery pumps in combination with hydraulic motors are used to obtain smooth, positive rotary motion of exceptional accuracy. Such pump-motor combinations are capable of moving large masses easily, and hydraulic systems can be made to respond to acceleration, deceleration and reversal signals quickly, but in a cushioned manner. These attributes are combined with the trouble-free operating life experienced with devices that provide their own lubrication and overload protection.

Illustrating the versatility of adjustable speed hydraulic drives is an application of some Oilgear Co. equipment to an enlarged paper laminating machine. The original machine, equipped with hydraulic drives, was modernized by various additions and modifications to enable it to produce a three-sheet laminate.

As modified, the laminating machine drive system contains a single variable displacement pump that provides power to four hydraulic motors in a unique arrangement. The single pump is controlled by an electric pilot motor actuated by pushbutton. The pump output drives two constant displacement hydraulic motors connected in parallel circuits that tandem-drive the center section of the laminating machine. These two motors also act as metering devices for the input to the two other hydraulic motors which drive the feed-roll and winder sections of the machine.

Connected in series with one of the tandem-motors is a variable displacement motor which drives the feed-roll section (a new section to the machine added during modification). Proportional speed relationship between the center and feed-roll section is varied by changing the stroke adjustment of the feed-roll drive motor. A valve in the hydraulic line between the center and new sections limits maximum torque obtained at the feed rolls.

The second tandem motor in the center section is connected in series with and meters fluid flow to a constant displacement motor which drives the winder section of the machine. Speed relationship between these two motors is controlled by torque demands as sensed by an automatic tension control valve as the roll diameter of the laminate on the winder increases in size. Hydrodynamic braking of the system is accomplished through two solenoid-operated valves.

With the circuit arrangement, control of the pump through its pushbutton station provides for simultaneous increase or decrease of the speed of all three sections of the laminating machine. In addition, the system provides for independent adjustment of the proportional relationship between speed of feed-roll and center section, and automatic adjustment of speed of the winder drive to maintain proper tension.

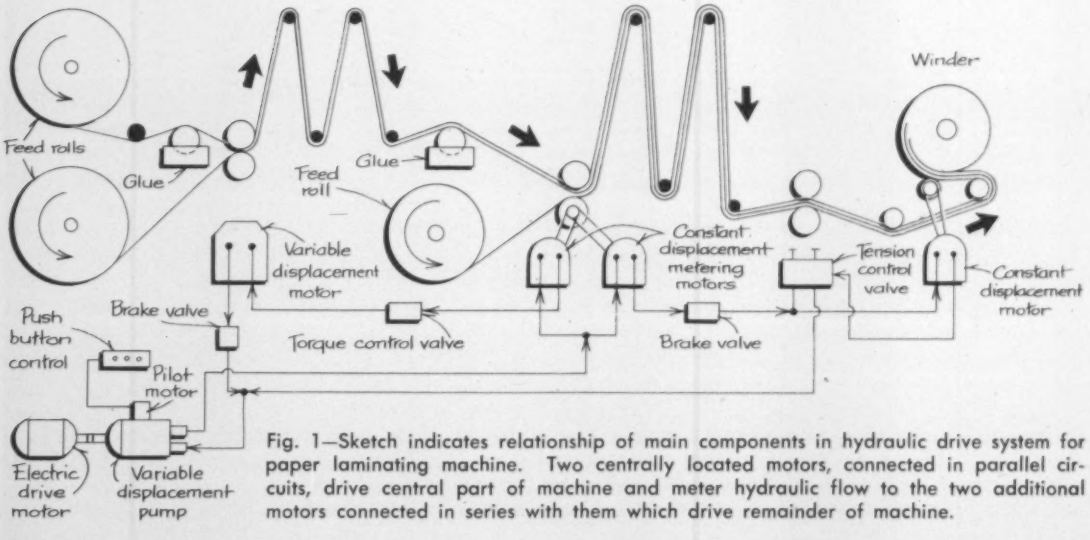


Fig. 1—Sketch indicates relationship of main components in hydraulic drive system for paper laminating machine. Two centrally located motors, connected in parallel circuits, drive central part of machine and meter hydraulic flow to the two additional motors connected in series with them which drive remainder of machine.

VERSATILE LOADING FIXTURE

AUTOMATES SMALL-LOT PRODUCTION

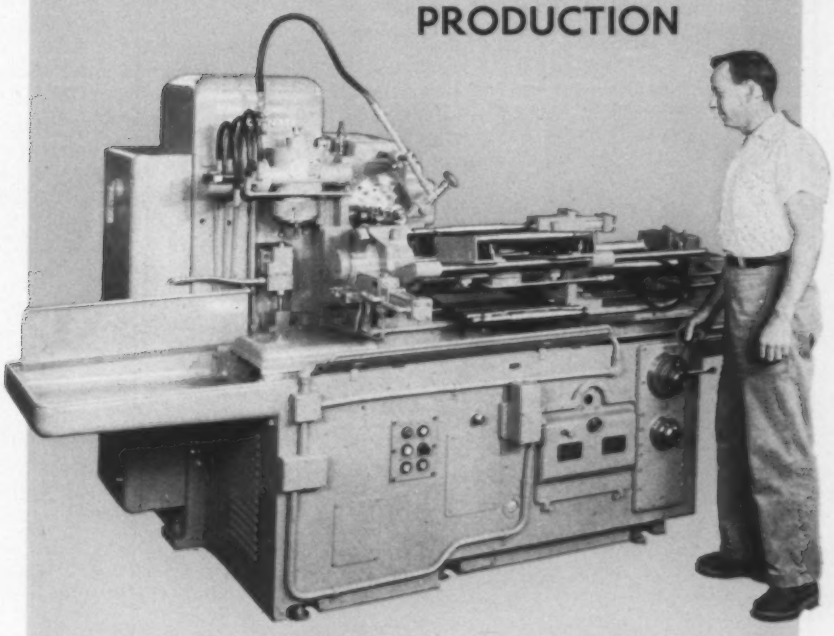


Fig. 1—Cincinnati plain rise and fall Powermatic milling machine is shown equipped with a hydraulically-operated loading fixture for use in automatically milling keyways or keyseats in motor shafts. Parts are manually loaded into the upper magazine of the fixture, automatically picked up and positioned between hydraulically-actuated clamping centers, milled for one to four keys, and unloaded into the lower magazine.

SMALL-LOT automation can be a major factor in reducing costs for short runs of similar parts in job shop operations. Many times it is readily attainable by using standard machine tools equipped with special tooling. A typical example of this approach is a standard milling machine tooled to produce keyways and Woodruff keyseats in a wide range of motor shafts. The Engineering Service Dept. of Cincinnati Milling Machine Co. equipped a standard plain rise and fall Powermatic milling machine with a hydraulically-operated, magazine-type loading fixture to automatically load and unload motor shafts for the milling operation, *Fig.* 1. Shafts up to 3½ inches in diameter and as long as 32 inches, *Fig.* 2, can be machined with as many as four separate keyways positioned along the same longitudinal axis. The versatile fixture and milling machine combination can machine a single key-

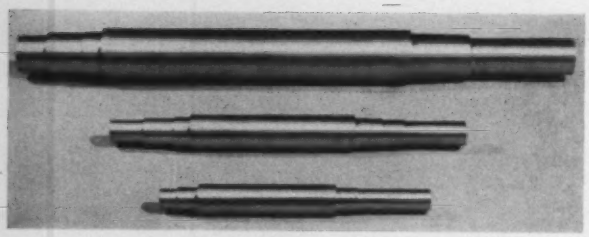


Fig. 2—Three shafts illustrate the versatility of the milling machine combination. The largest shaft measures 3½ inches in diameter at its largest part and is 30⅝ inches in length. The smallest shaft is 1 inch in diameter by 11 inches in length. Machine and fixture flexibility provide quick adjustments to accommodate various size shafts.

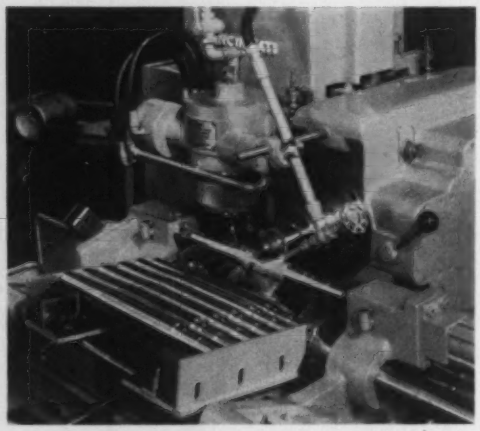


Fig. 3—Third keyway on a shaft is being milled automatically by the machine. The ends of the shaft are held in specially-designed, five-position loading disks which are quickly adjusted for different shaft sizes. Turret head above the workpiece controls the depth of cut.

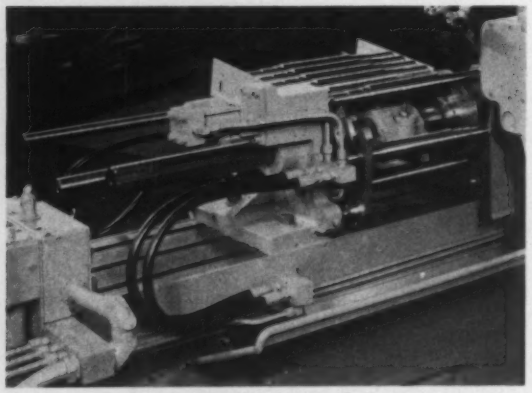


Fig. 4—Rear view of the loading fixture shows how shafts are unloaded into the lower magazine. The fixture is designed so that it will not jam if the lower magazine is not unloaded at the proper time by the operator. The unit will continue to unload shafts into the magazine, pushing finished shafts out of the front end of the magazine. Beneath the center of the shaft being machined is a spring-actuated, hydraulically-released jack. This device supports the shaft during milling and prevents shaft distortion.

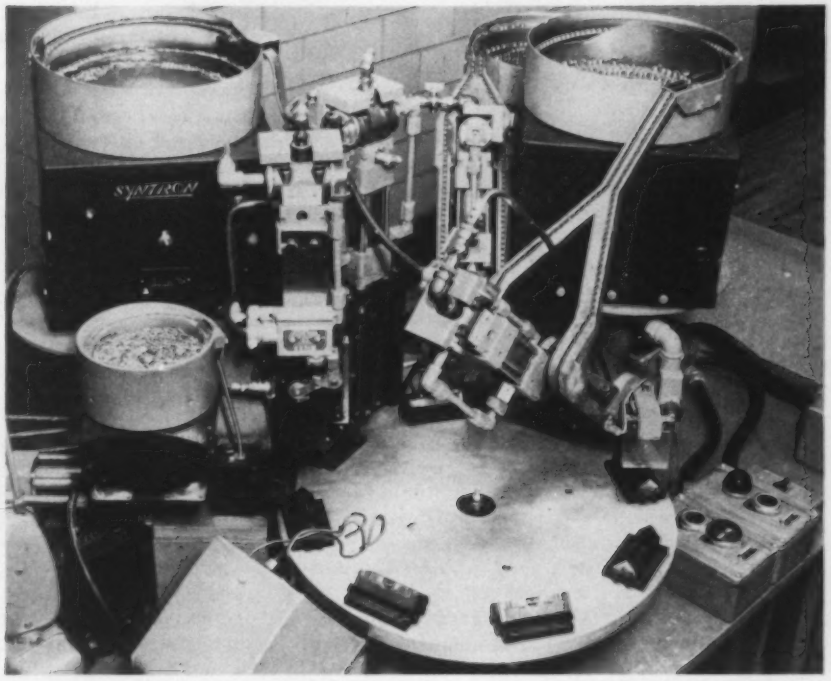
way in a 32-inch shaft with dimensions of 22-inches long by ½ inch wide by 17/64 inch deep.

The automatic loading fixture is used in conjunction with the automatic milling cycle of a standard Powermatic milling machine. Shaft parts are picked up from an upper magazine by a pair of V-slot loading discs and are automatically positioned between two hydraulically-controlled retracting centers. Hydraulic pressure then clamps the shaft against a positive stop on the lefthand headstock of the fixture. At this point the automatic milling cycle of the machine takes control and rapid advances the table to the first cutting position. The spindle carrier is lowered automatically to start the first keyway cut whose depth is controlled by a four-position turret stop, *Fig.* 3. After the first keyway is milled, the spindle carrier raises and the table rapid traverses to the next keyway position. This cycle continues automatically for each keyway being milled. Upon completion of the last cut, the carrier raises, the table returns to its initial position, the fixture centers retract hydraulically, and the finished shaft is automatically indexed into the lower magazine of the fixture, *Fig.* 4.

An operator is required to load and unload shafts from the upper and lower magazines of the fixture. A typical magazine load would consist of eight 2-inch diameter shafts. If the lower magazine becomes fully loaded due to operator inattention, the feeding mechanism will continue to eject finished parts, and excess shafts will be pushed out of the lower magazine. If production warrants, conveyors can be integrated with the unit to automatically supply blank shafts and remove finished units from the fixture.

When small lots of different size or length shafts are machined on this unit, changeover time between lots becomes an important factor. Incorporated in the fixture design are many features to reduce changeover time as much as possible. The righthand tailstock of the fixture is adjustable longitudinally along the machine table to accommodate various length motor shafts. The loading discs, which pick up and position the parts between the machining centers, consist of two plates having five V-slots. When changeovers are made for different shaft diameters, a series of setscrews is loosened and the two plates are rotated in relation to each other to obtain the proper size slot. If production is scheduled so that the fewest number of adjustments are required between lots, only fifteen to twenty minutes will be spent in making changeovers. However, the changeover time will be lengthened if there is a great difference in shaft diameters and lengths.

Production rates of the milling machine combination vary with the number of keyways required and the length of shaft being milled. For machining an 18-inch long shaft having three keyways and using a 2⅛ inch diameter staggered tooth cutter, 210 rpm, 120 sfm, and 12¼ ipm feed, a typical production figure would be approximately 68 parts per 50-minute hour. Average production for a keyseating operation using a ⅞ inch diameter keyseat cutter, 820 rpm, 120 sfm, and 10 ipm feed would be 220 finished shafts per 50-minute hour.



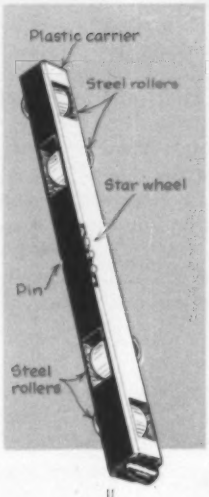


Fig. 1—Automated indexing machine assembles typewriter carriage trucks. Hand loading of the plastic carrier into the V-shaped fixture is the only nonautomatic operation. Four vibratory hoppers feed parts to the various stations and four air cylinders position the parts in the carrier unit.

INDEXING MACHINE SPEEDS

TYPEWRITER SUBASSEMBLY

Subassembly of small components furnishes many opportunities for applying automation techniques. In this example, electric typewriter carriage trucks are speedily assembled on an automated indexing machine.

By **CHARLES J. SAMMONS,**
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AUTOMATED assembly of electric typewriter carriage trucks has reduced costs and increased production at the Electric Typewriter Div. of International Business Machines Corp. The roller type trucks support the carriage assembly on V-shaped rails which guide the carriage back and forth during typing. The parts of the truck assembly are a phenolic plastic carrier, four ground steel rollers, a ten-lobe star wheel, and a star wheel pin.

The plastic carrier is approximately 2⅝ inches long and ¼ inch square with 1/16-inch bevels on each longitudinal corner. A slot ⅝ inch long is diagonally molded through the center of the carrier across two bevel corners. The

star wheel is inserted in this slot and held in place by the star wheel pin. The four steel rollers are located in molded slots of the plastic carrier. Rollers are used in preference to steel balls because they provide line contact and do not wear grooves in the guide rails. No bearings or pins are required for the rollers since they are held in place by small bumps projecting from the walls of the slots. During assembly, the plastic carrier is momentarily distorted as the rollers are pressed into place.

Four truck assemblies are used in each typewriter, i.e., two assemblies ride in each of two sets of V-shaped rails. Each set of rails has one section mounted on the machine casting and the other welded on a box construction forming the carriage support. Together, the rails form a diamond configuration. The rollers ride on the surfaces of the rails and are held in position by the plastic carrier. The star wheel engages gear racks cut into both the carriage and machine casting rails and keeps the trucks properly positioned with respect to the typewriter carriage.

Assembly of the carriage truck is done on an automatic, eight-station, indexing worktable, *Fig.* 1. The phenolic plastic carrier is manually loaded into a V-groove fixture at the first station, *Fig.* 2. The unit then indexes under a plastic guard which stops the machine if the carrier is not properly loaded. Two ground steel rollers are fed down a split track from a vibratory hopper at the third station and an air cylinder presses the rollers into the carrier.

The fourth station of the worktable feeds two more rollers into the inner slots and an air cylinder presses the rollers home. The ten-lobe star wheel is fed from a vibratory hopper at the fifth station and an air cylinder inserts the wheel vertically into the slot in the center of the carrier. A vibratory hopper at the next station feeds the star wheel pin to the unit and an air cylinder presses the pin into the plastic carrier as a second air cylinder holds the unit in the fixture. At the seventh station an air ejector blows the completed truck assembly out of the fixture into a chute leading to a tote box where completed units are accumulated. When the worktable indexes to the last station, the fixture is clear and ready for the manual insertion of a new carrier.

The automated assembly table produces approximately 600 truck assemblies per hour. The machine operator supplies the four vibratory hoppers, observes the indexing operation for proper functioning, and manually feeds plastic carriers into the fixtures. With further refinement, the operation can be made fully automatic and release the operator for other duties.

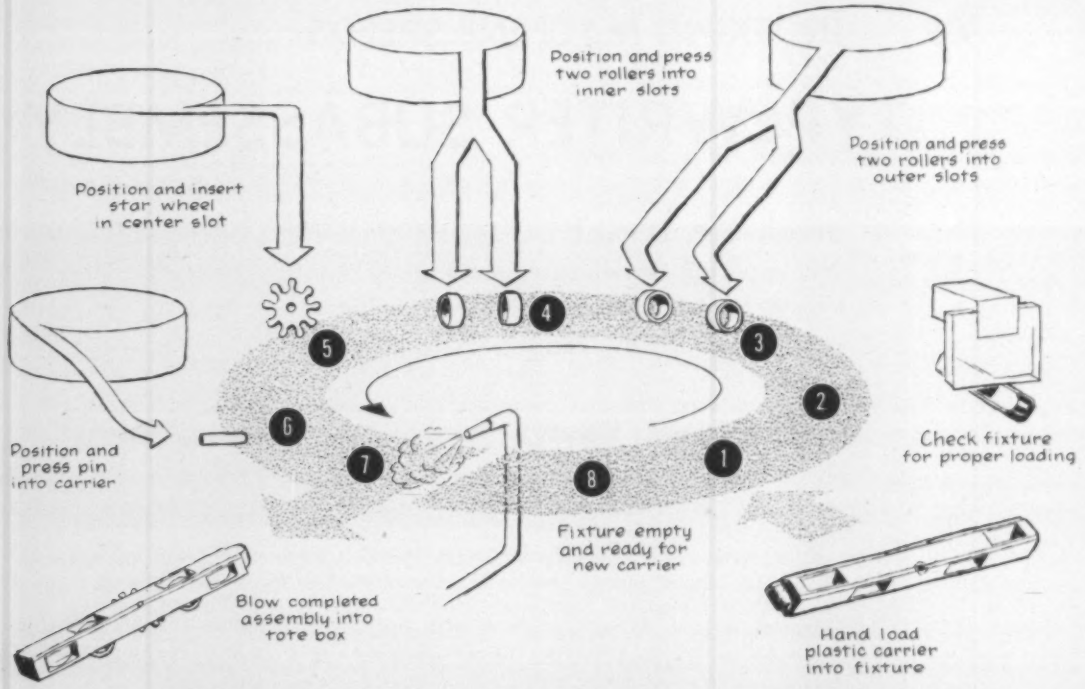


Fig. 2—Operations performed in the automatic assembly of carriage trucks on the 8-station indexing machine. Approximately 600 complete assemblies can be produced per hour.

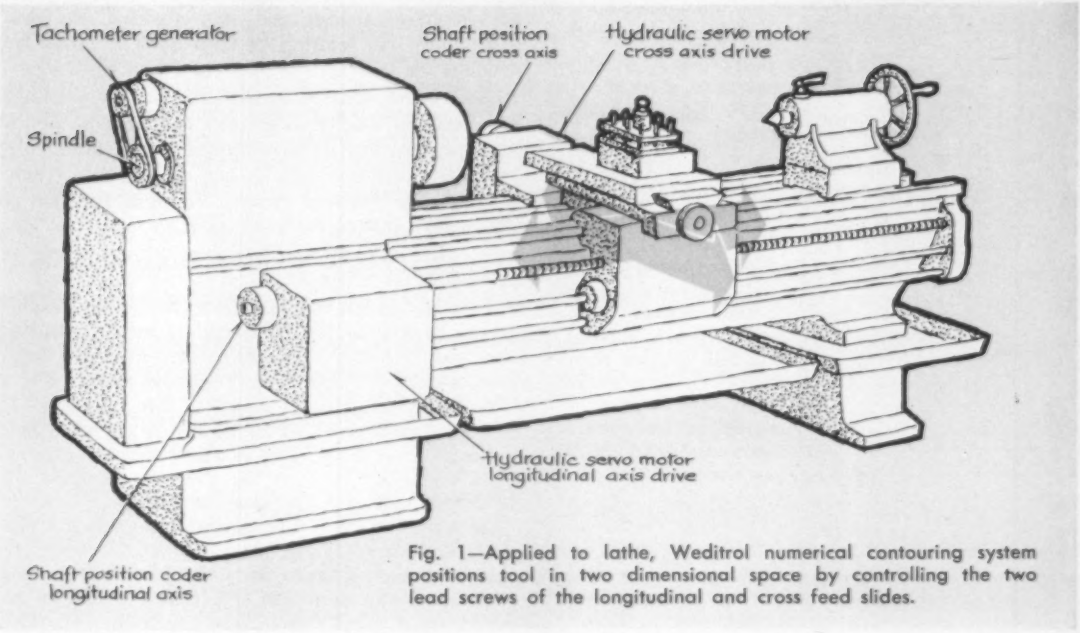

Tachometer generator
Shaft position coder cross axis
Hydraulic servo motor cross axis drive
Spindle
Hydraulic servo motor longitudinal axis drive
Shaft position coder longitudinal axis

Fig. 1—Applied to lathe, Weditrol numerical contouring system positions tool in two dimensional space by controlling the two lead screws of the longitudinal and cross feed slides.

ELECTRICAL IMPULSES PROVIDE

TWO-DIMENSIONAL CONTOURING CONTROL

Generating a contoured surface can be one of the most difficult and time consuming problems in machining of metals. Probably the most common case occurs where the desired part does not have regular geometric shape, is required in a short time, and is needed in small quantities. This is the ideal area of application for numerical contouring controls.

EACH NUMERICAL CONTROL system can be conveniently classified into one of two general types—either positioning or contouring. Positioning control of machine tools is primarily concerned with the accuracy of the position of a tool relative to a workpiece only at the completion of each numerical command. Contouring control is concerned at all times with the accuracy of the paths and positions of the tool relative to the work as numerical commands are executed. Both types of control are of increasing value to industry today.

Contouring control has proved to be a practical answer to production problems involving complex contouring operations where speed of production is important and frequent changeover of production items occurs. Typifying the imagination which underlies the design of numerical controls is an approach developed by Wang Laboratories Inc. The company manufactures the Weditrol system of numerical control, a system that is primarily applicable to contouring control.

First commercial application of the control has

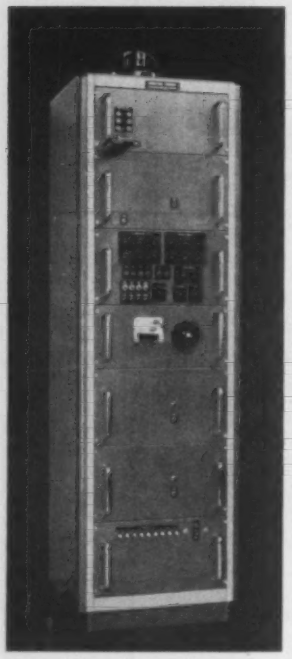


Fig. 2—Control cabinet for numerical control system houses major electronic equipment. Control receives directions from tape reader for automatic or semi-automatic operation. Dials are provided for manual operation.

been to a lathe, *Fig.* 1. For this application, instructions regarding cutting dimensions, directions, feedrates, selection of appropriate tools, etc., are prepared in coded form on a punched tape. The tape is then fed into a control cabinet which generates electrical commands for longitudinal-feed and crossfeed of the tool carriage slides, and for other miscellaneous functions. The punched tape, once prepared, serves as a permanent record and an instructive medium just as a blueprint or drawing. It can be used a number of times before it wears out. In actual production practice, a master tape is carefully prepared and filed in the engineering department. Secondary tapes are duplicated from the master for use in production lines.

The binary code employed by the control results in an extremely simple over-all system. The conversion of decimal dimensions, generally used in preparing drawings, to binary code is done on an auxiliary translator associated with tape preparation. The designers of the Weditrol followed the axiom that the procedure and circuits for reading the coded instructions on the tape to the delivery of a command signal to the actuating device should be kept as simple as possible. This simplicity in design is a vital factor in ultimate reliability and easy maintenance.

System Details

The major electronic equipment for the system, together with a tape reader, is housed in one cabinet, *Fig.* 2. A tachometer generator and two hydraulic servo systems, including two shaft position coder devices for the lead screws of the longitudinal-feed and crossfeed slides, are mounted on the lathe. The two electrohydraulic servo actuating devices drive the slides of the tool carriage in accordance with the longitudinal-feed and the crossfeed electrical commands. The cutting path of such a controlled single-point tool will be a straight line with a prescribed slope. Curved paths can be approximated by a series of short straight lines with varying slopes.

Employment of pulse multipliers for feedrate control along the two axes is one of the unique features of the Weditrol system. Principle function of the pulse multipliers is to generate electrical impulses with an appropriate rate corresponding to the desired feedrates.

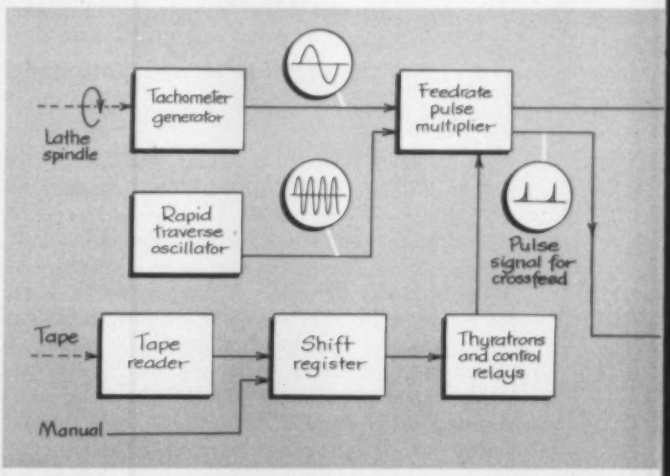
The tachometer generator is mechanically coupled to the spindle of the lathe and is used to provide electrical signals for the feedrates; thus, the feedrate is always a function of spindle speed. For a fixed spindle speed, a selection from a range of 31 feedrates is provided by means of the adjustable feedrate pulse multipliers in the electronic cabinet. This essentially replaces the gearbox found at the headstock end of a conventional lathe.

Another feature of the control system is the provision for an automatic slow approach feedrate. As the name implies, when the tool approaches the end position of one command, the feedrates will be reduced automatically to a slow approach rate. This feature insures no overshoot of the servo response at high feedrates.

An independent oscillator is also provided in the electronic cabinet to supply a constant frequency signal for rapid traverse during the return of the cutting tool. This rapid traverse feedrate is independent of the spindle speed.

Operational Details

During automatic operation, the first command read from the punched tape will be initially registered in a magnetic core shift register. It is then immediately transferred to a set of thyratrons and relays to direct the operation of the pulse multiplier system for longitudinal and cross feedrate control, together with other miscellaneous functions. A second command is immediately read into the



shift register as soon as the register is released of its previously registered command. The time duration of reading one command is about one-fifth of a second. Use of the shift register as an extra information storage means speeds up the over-all operation, especially during the cutting of complicated contours where a series of small incremental changes must be made.

The number of electrical impulses (as contrasted to rate of impulses) determines the exact feed distance that a slide moves along an axis at any one command. The arithmetic operation of counting pulses is controlled by an associated counter for each axis. The basic incremental distance of the feed is 0.0002 inch, corresponding to one electrical impulse. Thus, for a 30-degree cut of one inch distance along the longitudinal axis, the pulse multiplier will generate 5000 impulses for the longitudinal feed system and 2887 impulses for the cross feed system. Because both these pulse trains are simultaneously generated at uniform rates, the resultant motion of a tool will be a straight line at an angle of 30 degrees to the longitudinal axis. Each of the servo feed actuators is part of a separate closed loop control system consisting essentially of the following components: Reversible counter, digital-to-analog converter, servo actuator, shaft position coder device, and rate feedback circuit for stabilization.

The reversible counter within each servo system serves as a comparator. It has two inputs and one output. Either plus impulses or minus impulses from both the pulse multiplier and the shaft position coder device form the two inputs. The net number of impulses, as determined by the reversible counter, is the difference between electrical impulses of the command equipment, representing desired position, and the feedback equipment, representing actual position. This difference is thus a positional error of the servo system. The digital-to-analog converter converts the impulses representing positional error into a voltage with proper polarity which in turn drives the servo actuator.

Essentially, the shaft position coder device in each system serves as a digitizing means to provide feedback impulses corresponding to the position of a slide. The coder device is constructed with two circular printed circuit boards spaced close to each other; one is stationary and one is coupled to the lead screw shaft. The coder device will resolve each revolution into 1000 increments and, through the lead screw arrangement, the linear increment of slide motion is 0.0002 inch for each angular increment of rotation. An electrical impulse is generated for each increment of angular motion of the shaft. Two channels are provided: one generates impulses during clockwise rotation of the shaft and the other during counterclockwise rotation. Thus, the position of the slide at any instant is accurately measured by establishing a plus and minus value for the sense of rotation and counting the number of impulses in both directions as is done by the reversible counters in each of the servo circuits.

▶ Versatile System

The system is designed with three modes of operation: Automatic, semiautomatic, and manual. Punched tape is used in both types of automatic control. With semiautomatic operation, each tape command is initiated by a pushbutton, while for automatic operation the machine is programmed by itself. Manual operation is provided to make the system more flexible. For manual operation, instructions are fed into the system by dial switches located on the electronic cabinet.

It has been shown that basically the Weditrol system for lathe control is a punched tape programmed electronic digital system which can sense, command, and control distance increments of the cutting tool in any direction in two dimensional space by generating, counting, and controlling electrical impulses. By driving two axes of a work table instead of a tool carriage, the system is readily adapted to a milling machine requiring two dimensional contour control. By the simple addition of another pulse multiplier channel, the system can be applied to three dimensional control.

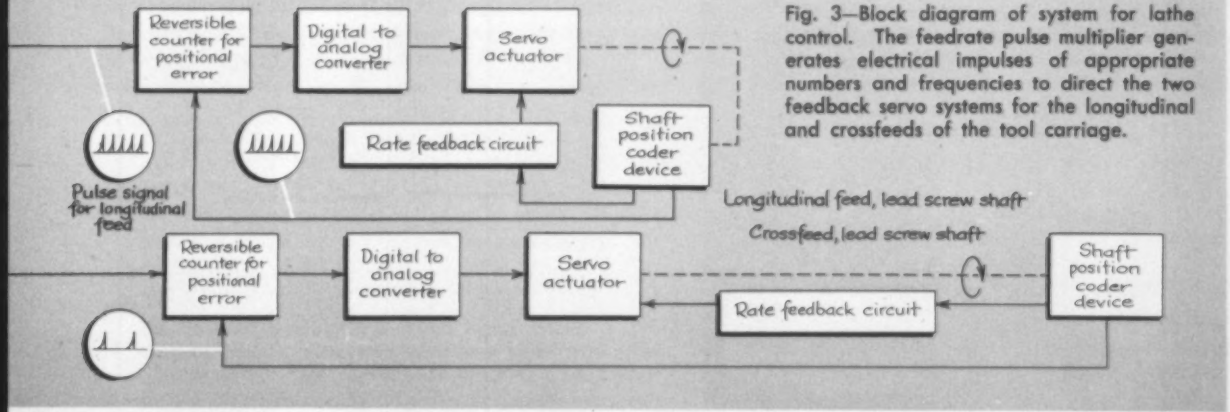


Fig. 3—Block diagram of system for lathe control. The feedrate pulse multiplier generates electrical impulses of appropriate numbers and frequencies to direct the two feedback servo systems for the longitudinal and crossfeeds of the tool carriage.

BUILT-IN TRANSFERS AUTOMATE MULTISLIDE PRESS

METAL STAMPINGS of small size are produced at high rates on a new machine built by Multi-Autoform Corp. The machine, *Fig.* 1, is an impact forming machine featuring three separate slides and an automatic arrangement for transfer between dies. The three rams are parallel and operate in a vertical plane. They are all operated by a single crankshaft which has three throws. The two outside rams travel up and down together, while the movements of the center ram are 180 degrees out of phase with the other rams.

Punches on the individual rams are separate units which are centrally located by pilots and angularly located by dowels. Dies under each ram are also individual units and are positioned by diamond-shaped locators in the bed of the machine. The relationship between the holes in the rams and the diamond locators is maintained within 0.0005 inch so that punch and die sets can be easily interchanged within a machine or between machines.

A transfer actuator, *Fig.* 2, is provided at each side of the press and mechanically synchronized with the ram motions. Each actuator operates a transfer tongue designed to move a specific workpiece between positions under two of the rams. In the setup shown, strip stock is fed from the rear of the press to the left ram. The workpiece is blanked and driven into a tight fitting cavity in the left transfer tongue. Just before the center ram descends the left and right transfer tongues are extended under it with the left tongue, which carries the blank, being above the right tongue. When the center ram comes down it pushes the work down into the right tongue and performs a piercing operation. After the center ram retracts the two tongues are retracted and the workpiece is carried under the right ram by the right tongue. In this setup, finish forming of the part is being done by the right ram which also drives the part out of the right transfer tongue and ejects it.

Where required, another set of feed rolls can be used to feed stock to the other outside ram. If stock is fed to the two outside rams and different parts made simultaneously, they can be automatically transferred to the center ram and assembled. The machine can also be used to perform three independent blanking operations.

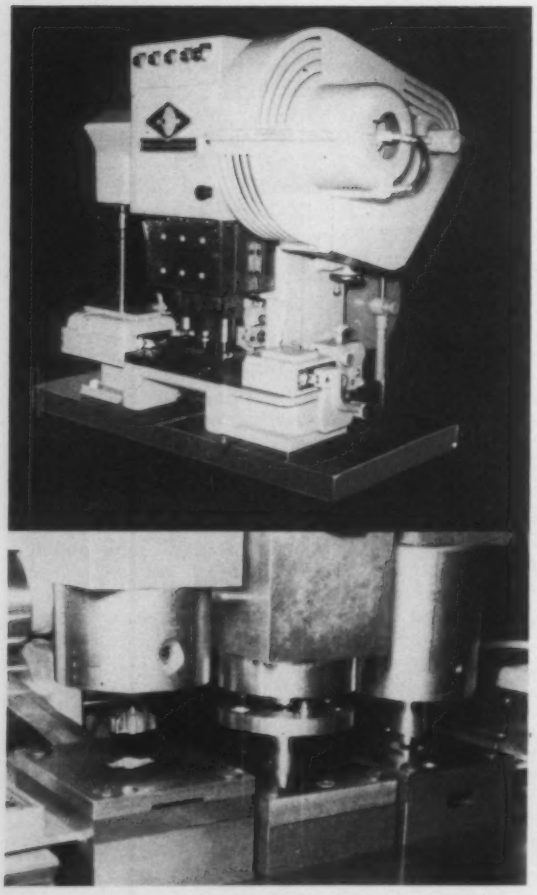


Fig. 1—Three-slide press with independent dies performs operations in the two outer dies while the center ram is up. Transfer tongues at each side move parts between positions under rams. Close-up shows strip stock being roll-fed to first operation.

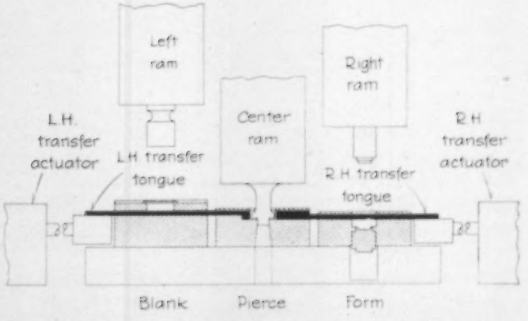


Fig. 2—Sketch shows positions of transfer tongues and rams after outer rams have moved up, transfer tongues have moved under the center ram, and the center ram has come down.

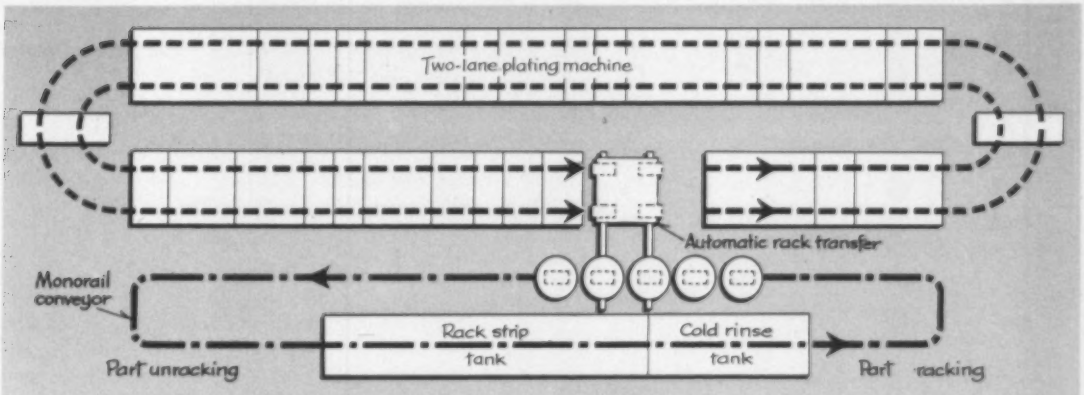


Fig. 1—Plan view shows automatic plating installation. Parts are loaded on racks manually; racks are automatically transferred to and from the plating machine; parts are then unloaded manually. Racks of parts receive a nickel and a chrome plate at the rate of 100 racks per hour.

TRANSFERRING RACKS AUTOMATICALLY

BETWEEN CONVEYOR AND PLATING MACHINE

By **RALPH L. EVERSTINE**, Chief Electrochemist, Stamping Div., Eaton Mfg. Co., Cleveland, Ohio

HANDLING is a major problem in the plating of discrete parts. One answer to this handling problem has been to build plating machines which carry groups of parts on racks through desired steps. However, racks loaded with parts are difficult to move on and off the plating machine. To solve this problem an installation at an Eaton Mfg. Co. plant incorporates a mechanism to automatically transfer loaded racks of raw parts from a monorail conveyor to the plating machine and to transfer racks of plated parts back to the monorail.

The system, *Fig.* 1· was built by Hanson-Van Winkle-Munning Co. Parts to be plated are manually loaded on racks which are carried by an overhead monorail conveyor. The conveyor moves the racks to the transfer mechanism which loads two racks on each carrier of the plating machine. The carriers are moved around the plating machine and can be immersed in 30 different tanks to apply a nickel and a chrome plate to each part. Racks of plated parts are removed from the plating machine by the transfer mechanism and replaced on the monorail conveyor. The plated parts are then manually unloaded from the racks, which are carried through stripping and rinse tanks and back to the racking area.

This system replaces a previous system which required manual moving of racks into a nickel plating operation, manual transfer of racks to a chrome plating operation, and manual removal of racks from the chrome plating operation. Production was limited by the weight of parts that could be hung on a rack that must be transferred by hand. In an effort to overcome delays and increase output, the system was subjected to constant overloading, which resulted in frequent breakdowns and excessive downtime for maintenance. The new automatic system allowed use of racks holding more parts, and with larger solution tanks, capacity was nearly doubled. Production jumped from a former 25,000 plated parts per 24-hour day to 48,000. These parts range from 10 to 34 inches in length and weigh from ½ to 8 lbs. The amount of physical effort required has been drastically reduced, and plating room operators are now concerned only with supervision and servicing of the automatic plating system. Improved quality has significantly lowered the number of rejects, saving time and money formerly spent in doing work a

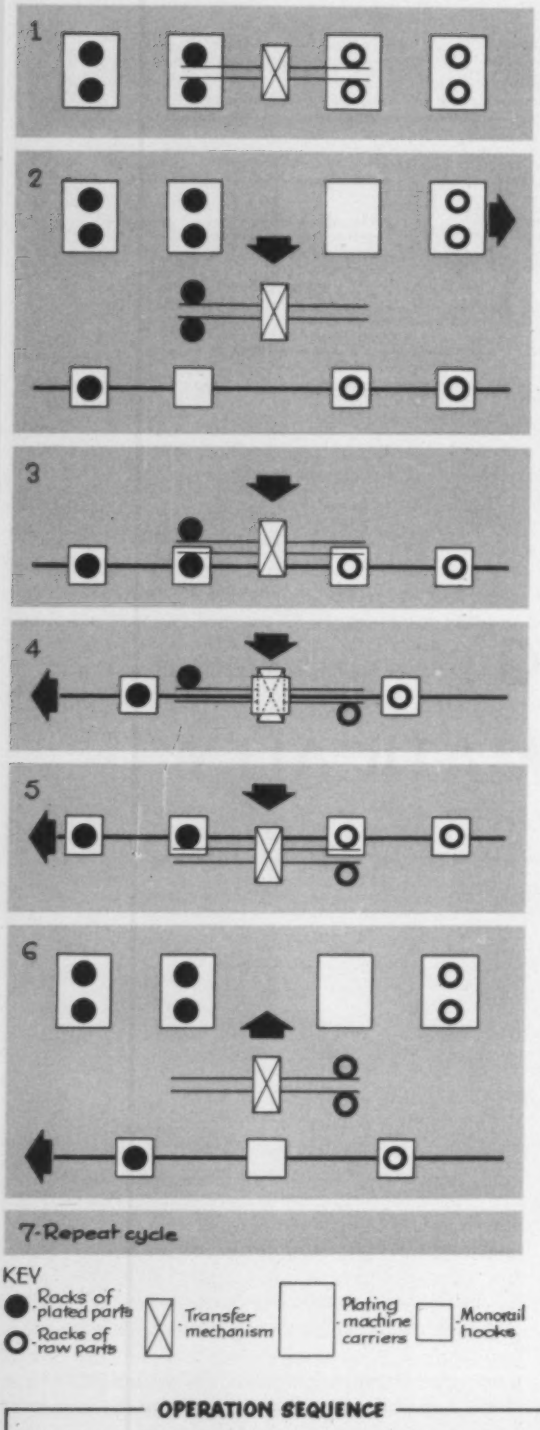


Fig. 2—Diagram portrays steps in handling cycle as transfer mechanism shuttles racks of raw parts onto the plating machine from the monorail and racks of plated parts back to the monorail.

second time. Also, production goals are now met without overloading the system, thus eliminating considerable maintenance downtime.

How It Works

Racks of raw parts are intermittently moved into position at the transfer mechanism by hooks on the monorail conveyor, *Fig.* 2. Racks of plated parts move away on the same hooks. There is no separation of raw and finished stock onto alternate hooks. The automatic transfer mechanism shuttles on a pair of rails to carry racks between the monorail conveyor and the plating machine. It has two stations for racks of plated parts and two stations for racks of raw parts. Control mechanisms and drive units for the transfer mechanism—gear motors, electrical devices, chains, and sprockets—are conveniently located for accessibility.

Every 72 seconds, two racks of newly-plated parts are positioned properly at the unload station of the plating machine. A signal then causes the automatic transfer, which is carrying two racks of raw parts, to move into position at the plating machine, *Fig.* 3. Lifting cranks, *Fig.* 4, one for each lane of the plating machine, lift the two racks of plated parts onto the transfer mechanism. At the same time, the two racks of raw parts on the other side of the transfer mechanism are placed on an empty carrier of the plating machine by two more lifting cranks.

The transfer mechanism then shuttles to the monorail. Here the rack of plated parts from the outside lane of the plating machine is deposited on a hook on the monorail, while a rack of raw parts is picked off the monorail. The transfer mechanism then repositions as the monorail moves ahead one hook spacing. A rack of raw parts is taken from the monorail by the transfer, and the rack of plated parts from the inner lane is put on the monorail, *Fig.* 5. The transfer mechanism then returns to the plating machine and the monorail advances one more hook spacing.

All controls for the three conveying elements—monorail, transfer mechanism, and electroplating

OPERATION SEQUENCE

1 – Transfer deposits 2 racks of raw parts on plating machine and simultaneously picks up 2 racks of plated parts.
2 – Transfer moves to monorail; plating machine carriers advance 1 step.
3 – Transfer deposits 1 rack of plated parts on monorail and simultaneously picks up 1 rack of raw parts.
4 – Transfer moves to other side of monorail; monorail hooks advance 1 step.
5 – Transfer deposits second rack of plated parts and simultaneously picks up second rack of raw parts.
6 – Transfer returns to plating machine; monorail hooks advance 1 step.
7 – Cycle repeats.

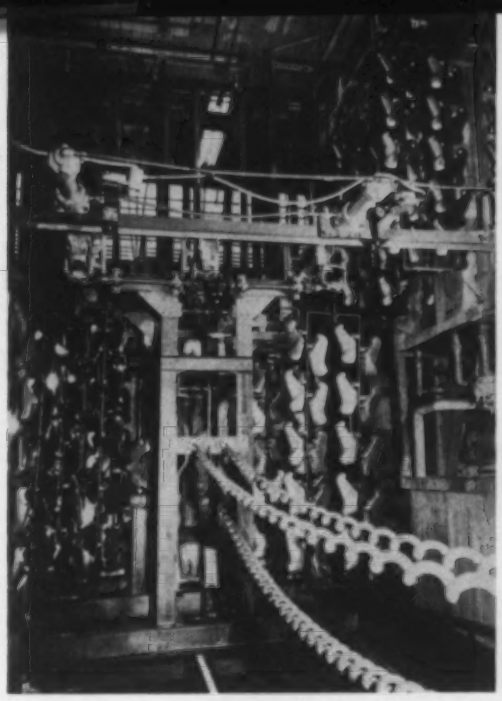


Fig. 3—Transfer mechanism is shown in position to take two racks of plated parts off plating machine at left and deposit two racks of raw parts on plating machine at right. Racks at upper right are being carried into the plating process by the plating machine. Coiled cords carry power to the transfer mechanism as it shuttles between plating machine and monorail.

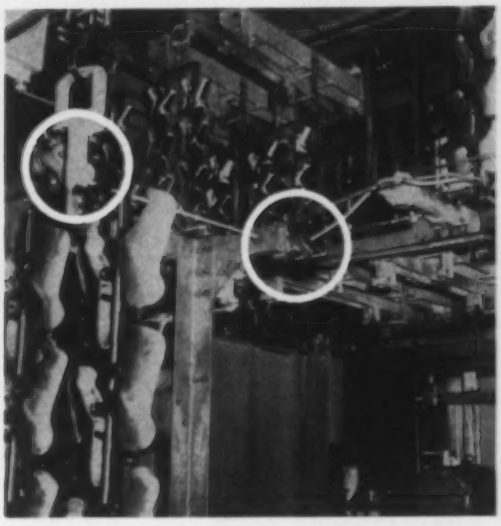


Fig. 4—Transfer mechanism is here ready to pick up a first rack of raw parts from a monorail hook. Circles indicate the cranks which lift racks off the monorail hooks and deposit them on the plating machine carriers at right.

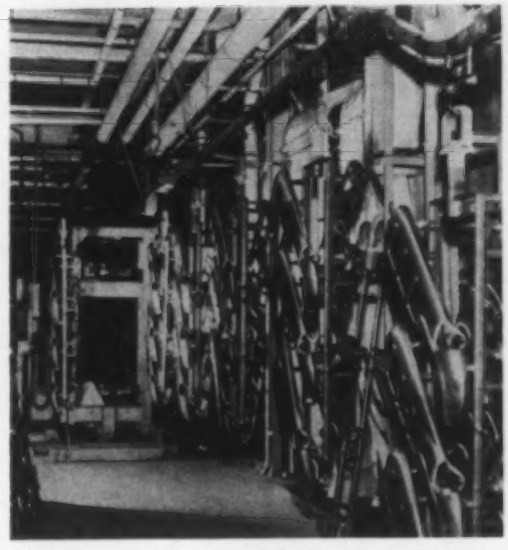


Fig. 5—After the monorail advances one hook spacing and the transfer mechanism repositions, the transfer is ready to take a second rack of raw parts from the next monorail hook. Racks of raw parts are advancing from the right toward the transfer mechanism at left. The transfer will shuttle them to the plating machine which is on the far side of the monorail.

machine—are located in a centralized panel. They are connected to allow restarting of a cycle from any point of the cycle. Either lane of the plating machine may be operated alone, or both may be operated at the same time. This permits closing down one lane for servicing of solution tanks without completely halting operation. Manual controls for all elements permit forward or reverse jogging into any desired position.

▶ Plating Operation

The plating machine finishes 50 carrier loads of racks in an hour. The entire double-plating operation, which includes 30 different immersions, requires 2 hours and 12 minutes. Transfer time from one tank to the next is 40 seconds.

Raw parts first pass through several washes, acids, and cleaners. They then reach the nickel-plating tank where they remain for 50 minutes before further rinsing. Immersion time in the chrome tank is 5 minutes. After several more rinses, the electroplating is completed, and the finished parts arrive at the station where the transfer mechanism returns them to the monorail.

A special feature of this process is that any one of the tanks containing cleaners or acids may be bypassed. There also may be one plating bypass operation; after the parts have gone two-thirds of the way through the nickel tank, they can be raised and will bypass the remaining one-third of the nickel tank. The two lanes may be operated at different current densities; this permits segregating different sizes and shapes for best plating.

VERSATILE TRANSFER MACHINE

RUNS INTERMIXED DESIGNS

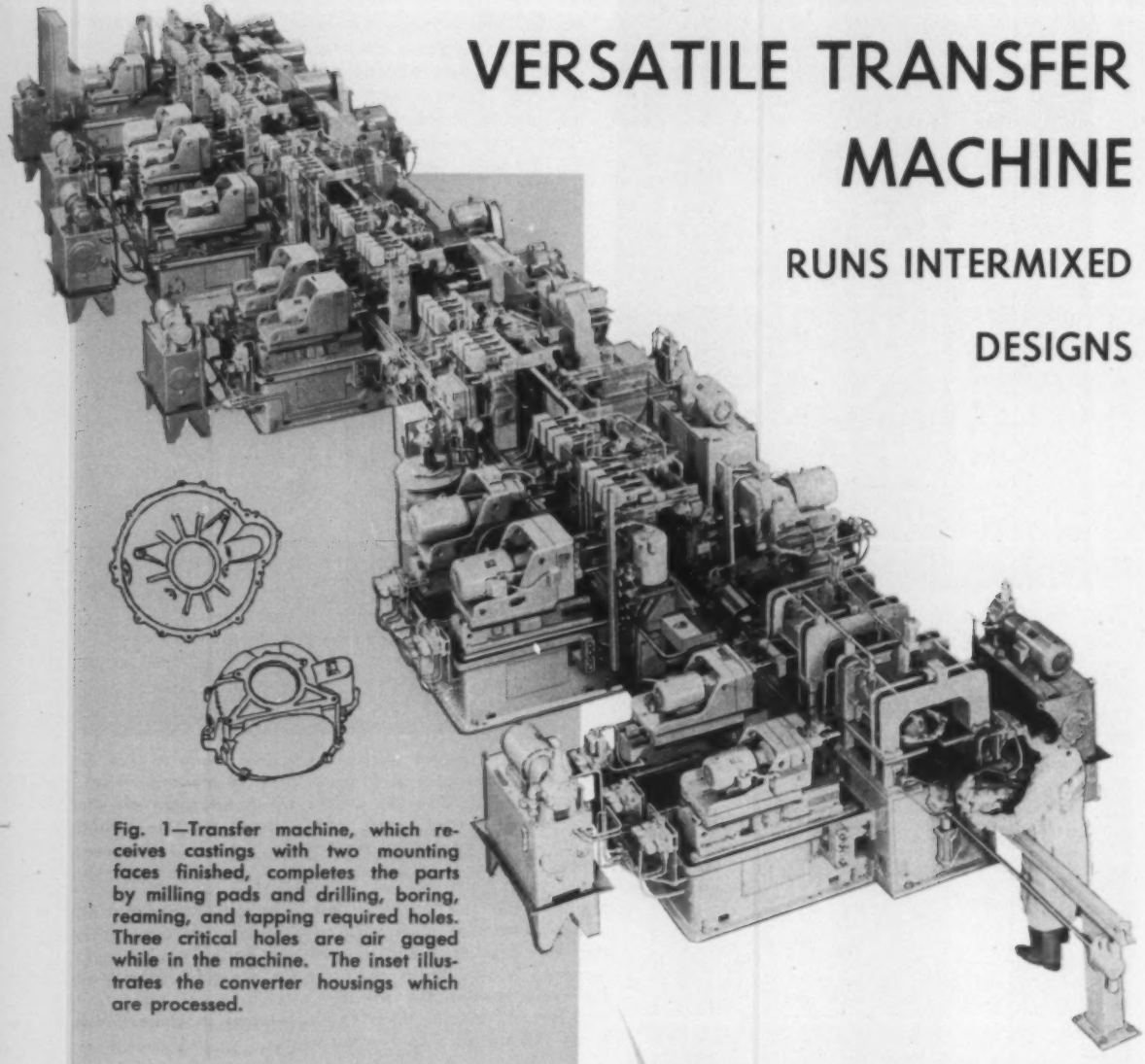


Fig. 1—Transfer machine, which receives castings with two mounting faces finished, completes the parts by milling pads and drilling, boring, reaming, and tapping required holes. Three critical holes are air gaged while in the machine. The inset illustrates the converter housings which are processed.

Installation for automobile converter housings shows high degree of adaptability. It processes any of three part designs, two intermixed, machines either cast iron or aluminum, and uses sectionalized design of bases and machine elements offering interchangeability for machine revisions.

WHEN the Ford Motor Co. bought a transfer machine to finish converter housings, *Fig.* 1, they didn't want a single purpose unit that could handle parts of only one design and then would be obsolete. The unit they bought from Buhr Machine Tool Co. incorporates features making it adaptable for processing three different part designs, and the workpieces may be either cast iron or aluminum. When design changes demand, the interchangeable bases and other parts of the machine can be rearranged, units added, or units removed.

▶ The Job To Be Done

The workpieces are castings for converter housings used with automatic transmissions. Parts come to this machine with the transmission mounting face and flywheel face finished. The transfer machine completes the machining of the parts. The machine does drilling, boring, counterboring, reaming, and tapping of various locating and mounting holes. Pads

located on the housing are also milled, drilled, and tapped.

Three different part designs can be machined. Two designs may be fed to the machine intermixed, and limit switches at individual stations sense which design is in the station so that the machining head will advance only for the selected design. Each part made to these two designs has 68 machining operations and 14 probing and gaging operations performed on it. Twelve of the machining operations and four of the probing operations are different between these two designs.

The third part design requires fewer operations than the other two, and the machine can be set to run this third design by positioning a selector switch which locks out machining units not required for that design. Parts of the three designs may be specified in cast iron or aluminum, and production at a rate of about 100 parts per hour or better is desired.

▶ The Machine

The transfer machine that performs the desired operations is a sectionalized installation having seven main bases linked by six idle or part positioning stations. Each main base provides two stations for operations. Counting the manual loading station and a station for automatic unloading to a conveyor, there are 22 stations in the installation. The bases carry 18 machining units, three probe units, and an air gaging unit. The 18 machining units mount a total of 72 spindles, some of which swing multipurpose tools.

Workpieces move through the first 18 stations of the machine on hardened steel rails. Intermittent advance of the work is accomplished by a hydraulically actuated reciprocating transfer bar carrying transfer fingers, *Fig.* 2. While the machining units cycle, the transfer bar rotates to clear the transfer fingers under the work, retracts by one station spacing, and rotates to engage the work for the next advance. When the operating units all return to their retracted positions, the transfer is ready.

Two manufacturing holes are drilled and reamed in Stations 2 and 3, and these holes are used for locating the part at succeeding stations. After parts have been advanced along the rails by the transfer bar, hydraulically operated locating pins insure accurate positioning. The work is clamped in position on the first six bases by clamp bars actuated through rack and pinion arrangements by hydraulic cylinders. These bases have as many as eight clamp bars all actuated by a single cylinder on each base. Each clamp is locked in the clamped position by a tapered wedge held down by a weight. When the work is to be unclamped, a second hydraulic cylinder on each base raises the locking wedges and weights to allow retraction of the clamp bars.

At Station 19 the part is rotated 90 degrees about an axis parallel to its line of travel through the machine. A walking beam mechanism then transfers the work through the rest of the stations. These handling devices are also hydraulically actuated.

All holes to be tapped are probed before tapping to insure clear holes for the taps. Three holes whose sizes are critical are automatically checked by an air gage arrangement. To insure accurate center distances between these holes and also a fourth one, the final finish boring or reaming operations on the four holes are performed by a single machining unit.

Since the workpieces may be specified in aluminum as well as cast iron, the machine is arranged so that it can be changed over from one to the other with a minimum of downtime. To provide the change in cutting speeds required to shift from cast iron to aluminum, every spindle head is equipped with change-gear boxes. All spindles are also arranged for pre-setting of cutting tools to minimize downtime for tool changes.

Production rate for cast iron parts at 100 per cent

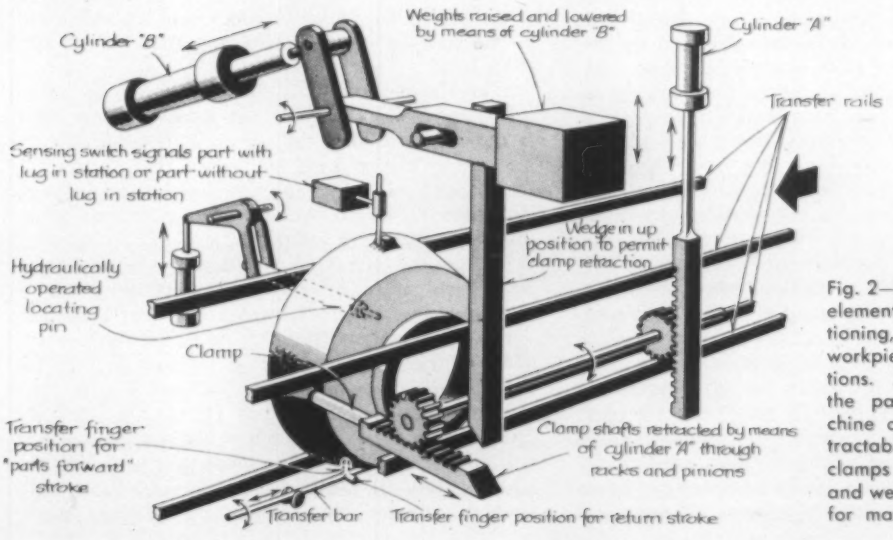

Cylinder "B"
Weights raised and lowered by means of cylinder "B"
Cylinder "A"
Transfer rails
Sensing switch signals part with lug in station or part without lug in station
Wedge in up position to permit clamp retraction
Hydraulically operated locating pin
Clamp
Transfer finger position for "parts forward" stroke
Clamp shafts retracted by means of cylinder "A" through racks and pinions
Transfer bar
Transfer finger position for return stroke

Fig. 2—Sketch indicates major elements for transfer, positioning, and clamping of workpieces at individual stations. A transfer bar indexes the parts through the machine on transfer rails. Retractable locating pins and clamps locked by weights and wedges position the work for machine operations.

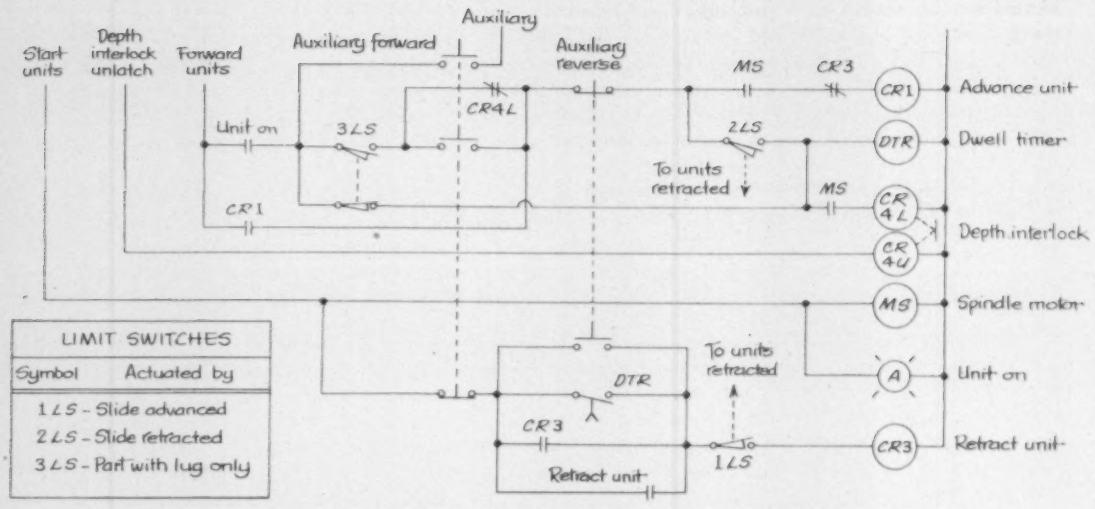


Fig. 3—Schematic diagram shows electrical circuits for a unit on the machine which advances only when the workpiece in the station has a special identifying lug. When a workpiece without the lug is in the station, the probe or machining unit remains in the retracted position when the other units on the machine advance.

efficiency is 120 pieces per hour. Elements of the cycle are as follows: Index 3 sec, clamp 3 sec, rapid advance 2 sec, machining 16 sec, dwell 1 sec, rapid return 2 sec, and unclamp 3 sec. Production rate for aluminum parts becomes 171 parts per hour since the machining time is cut to 7 sec and all other cycle elements remain the same.

Ways and moving parts on the machine are automatically lubricated, and chips are automatically removed by a drag link chip disposal conveyor. Coolant capacity required is 400 gpm, and total horsepower on the machine is 105¾.

▶ Machining Intermixed Parts

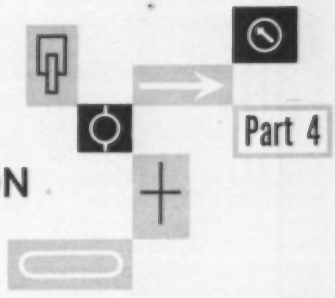
The two designs of parts which can be fed to the machine intermixed are identified by the presence or absence of a special lug—parts of one design each have such a lug, parts of the second design do not. Since the two designs have many features in common, 12 machining units, one probe unit, and the air gaging unit perform their functions on all workpieces of both designs. Three more machining units and one probe unit function only for a first part design and not a second; while three other machining units and another probe unit function only for the second design.

Each unit which performs its functions on only one of the two designs is selectively actuated in accordance with the condition of a limit switch associated with that unit, *Fig.* 2. This limit switch is in one of two positions as determined by whether the workpiece in that station has the identifying lug or not. When the over-all machine cycle energizes the *Units Forward* circuit, the selective unit is either advanced or left in the retracted position depending on the condition of the limit switch. Those units which perform their functions on workpieces of both designs do not have such limit switches in their control circuits, and therefore will advance during every machine cycle.

The unit control circuit for a selective unit is shown in *Fig.* 3. This unit is one which advances only when a part with the identifying lug is in the station. During a normal cycle when such a part is present, limit switch 3*LS* is actuated by the lug on the part. This closes normally open contacts in the limit switch and completes the circuit to the *Advance Unit* relay, *CR*1, when the *Forward Units* line is energized. Tripping this limit switch also opens normally closed contacts in the *Depth Interlock* circuit so this unit will have to advance to depth and latch the *Depth Interlock* relay, *CR4L*, before the machine's *All Units To Depth* circuit is closed. Completion of the *All Units To Depth* circuit allows the next machine function to start. The latch type relay used in the *Depth Interlock* circuit is unlatched at the completion of the index portion of the machine cycle.

When a part without the identifying lug is in the station, the circuit to the *Advance Unit* relay is not complete, and the unit will not advance on that cycle of the machine. Since the contacts in the *Depth Interlock* circuit are closed, the machine's *All Units To Depth* circuit will be completed when the other units reach full depth.

The control circuit for a unit which is to advance only for workpieces without the identifying lug is the same as the circuit for the unit just described, with one exception. The contacts in the limit switch 3*LS* are transposed so that its contacts in the *Advance Unit* circuit are normally closed, and its contacts in the *Depth Interlock* circuit are normally open. When the limit switch is not tripped the unit will advance. When it is tripped, the unit will not advance, but the *Depth Interlock* relay, *CR4L*, will latch to complete the *All Units To Depth* circuit.



BASIC PNEUMATICS FOR AUTOMATION

COMBINATION PNEUMATIC CIRCUITS

Designers of automated production equipment often find it to their advantage to combine pneumatic, hydraulic, and electrical circuits. Air pressure can be used to provide control signals or power for hydraulic actuation. Electrical control circuits offer interlocking control of pneumatic motions.

By H. L. STEWART and J. M. MORITZ, Logansport, Ind.

PAST INSTALLMENTS have shown some of the less complicated pneumatic circuits, which the designer may use for effecting various movements. In designing automatic equipment the engineer is also faced with the more complicated types of pneumatic circuits. He must learn how to interlock the movements which the pneumatic circuit provides with other movements of the equipment which he is designing. It should be remembered that pneumatic pressure is versatile and can be used not only for pneumatic devices, but can be used for operating hydraulic, mechanical and electrical devices.

Pneumatic-Hydraulic Combinations

Using pneumatics as the power means to intensify oil or water pressure, *Fig.* 21, has a number of advantages to offer. Such systems:

1. Eliminate the heat condition that is created by a hydraulic pump spilling oil through a relief valve at high pressure. Often it is necessary to hold pressures for a long period of time and oil going through the relief valve creates considerable heat and may cause requirements for coolers to keep the oil temperature within a safe operating range. Even if gas-type accumulators are used permitting unloading of the pump, the pressure will drop off as the fluid leaks away due to internal leakage.

2. Reach pressures that are higher than those available with a commercially available hydraulic pump. For example, an air intensifier with a 200 to 1 ratio operated by 100 psi line pressure will produce oil at a theoretical pressure of 20,000 psi.

3. Provide hydraulic pressure for full length of intensifier stroke with no variation of pressure as long as air pressure does not fluctuate.

4. Provide high pressure at relatively low cost. An intensifier unit is less expensive than a special hydraulic pumping arrangement to produce extremely high pressures.

5. Are compact in design. The intensifier does not require much space and can be located in any convenient place.

6. Can be used conveniently in highly explosive atmospheres, since the intensifier has no electrical connections.

The designer should also know of the disadvantages of the pneumatic intensifier and can prepare his design accordingly.

1. The requirements for the intensified fluid must be accomplished before the stroke of the intensifier is completed, else the pressure will immediately drop off, making the intensifier useless for the application.

2. Where very high intensification takes place, seals often present a problem. It is still difficult to seal a reciprocating member under very high pressures.

3. Where the fluid is water or other liquid that will cause corrosion, corrosion-resistant materials should be used

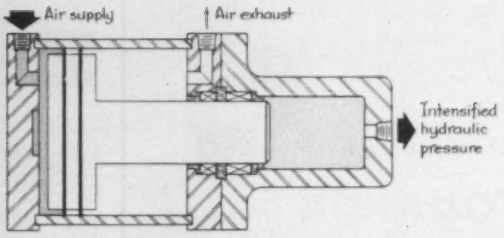


Fig. 21—Air-hydraulic intensifier that utilizes air line pressure to create a pressure in a hydraulic system. Standard air cylinder construction is used on the pneumatic side of the intensifier.

in the intensifier. Satisfying this condition involves additional cost. The ram should be stainless or chrome plated steel finished to a high degree of smoothness to resist pitting and reduce packing friction.

4. Special connections will be required on the intensifier chamber when fluid is intensified beyond the pressure for which pipe threads are recommended.

Illustrated in *Fig.* 22 is a circuit making use of an intensifier. The arrangement is used for automatic testing of tubing. Here water is the fluid which is being intensified. In this circuit, each tube is automatically fed into the test station. Limit switch *LS*-1 is tripped, momentarily energizing solenoid *N* of four-way valve *A*, shifting spool and directing air to blind end of clamp cylinder *B*. Piston moves forward, firmly clamping tube in fixture. As clamping takes place, cam on tail rod of cylinder *B* momentarily trips limit switch *LS*-2 and solenoid *P* of valve *C* is energized shifting spool and directing air pressure to blind ends of seal-lock cylinders *D* and *E*. Their pistons move forward and through a mechanical device provide seal under a force that the testing pressure cannot overcome.

On each of the sealing devices is a port. One is an inlet and the other an outlet. When the seal locks are in place, limit switch *LS*-3 is momentarily contacted and a timer is energized starting an electrical cycle which functions as follows: First set of contacts in timer is made, energizing solenoid of valve *F*, which opens a low pressure water line and the water flows through the high pressure check valve *G* into the tube and out through small, normally-open air-operated shutoff valve *H* until air is bled from tube. Contacts in the timer then energize three-way solenoid valve *J* and air flows to actuator of valve *H*, which closes valve. Simultaneously, timer contacts release current from solenoid of valve *F*, closing this valve. Contacts on timer then energize solenoid *S* of valve *K*, shifting its spool and directing air pressure to blind end of intensifier cylinder *M*. Piston starts forward intensifying water pressure and due to high pressure check valve *G*, the water cannot get to valve *F*.

When testing cycle is completed contacts on timer release current to solenoid *S* of valve *K* and then momentarily energize solenoid *T* of valve *K*. Spool shifts directing air to rod end of intensifier cylinder *M* and cylinder piston is retracted. Contactor releases current to solenoid of valve *J*, which in turn causes valve *H* to be opened draining water from tube. Contactor then energizes solenoid *R* of valve *C*, shifting its spool. Air is directed to rod ends of cylinders *D* and *E* and the seals are released. Contactor then energizes solenoid *U* of valve *A* and air is directed to rod end of clamp cylinder releasing workpiece which is automatically ejected. Timer resets and next tube is moved into fixture.

Another important application of the air-operated intensifier is shown in *Fig.* 23 where high pressure water is used to expand metal. By using this method of expansion, long expensive mandrels can be eliminated. Such mandrels often present problems especially where long lengths of small diameter tubes are to be expanded. The setup also eliminates the need for an expensive, long stroke cylinder. Another feature of using water for expansion is that tubes bent into *U* shapes can be readily expanded without any fancy tooling.

Control Actuator

In the preceding articles it was shown how air pressure could be used in conjunction with a closed hydraulic system for providing fine feeds and to effect synchronized motion. Pneumatic pressure can be used to advantage in conjunction with a hydraulic control system.

A testing operation application, *Fig.* 24, employs both air and hydraulics. Here the workpiece is fed into a fixture under ram cylinder *A*. Operator shifts

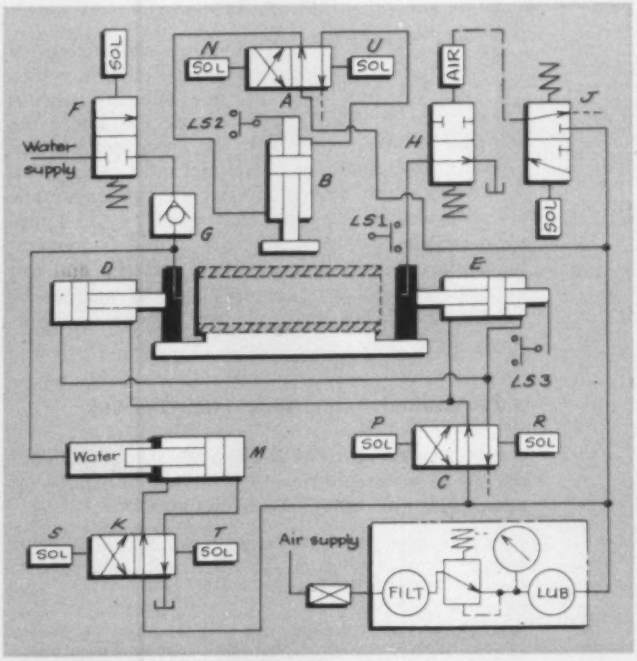


Fig. 22—Pneumatic-hydraulic circuit for water testing of tubing. Intensifier M is used to build up test pressure in the workpiece.

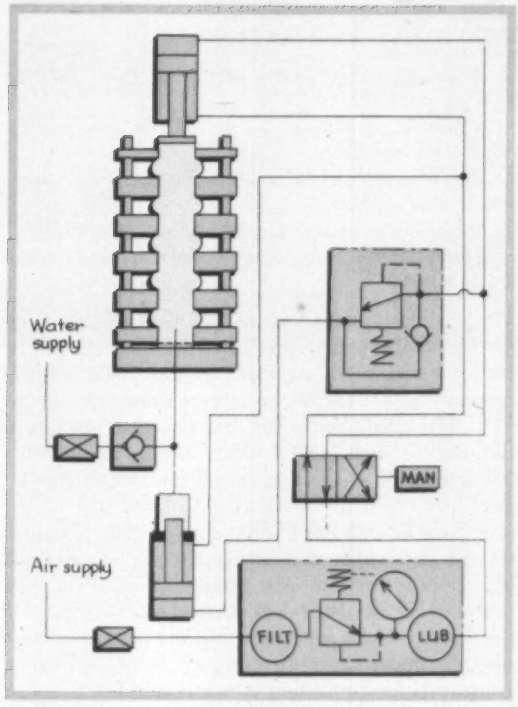


Fig. 23—Circuit uses intensifier to supply hydraulic pressure for expansion of tubing.

handle of four-way two-position hydraulic valve *B* directing oil to the blind end of ram cylinder *A*. Ram descends under low pressure until ram contacts workpiece. Operator then shifts handle of four-way three-position air valve *C* and air flows to blind end of air-hydraulic cylinder *D*. Piston of air-hydraulic cylinder *D* starts forward at a speed controlled by flow control valve *E* on closed hydraulic circuit. On this cylinder, a cam on end of piston rod contacts cam roller on variable hydraulic relief valve *F* and pressure starts to build up in hydraulic system. Operator shifts handle of valve *C* back to neutral position when pressure gage in line to cylinder *A* shows the desired pressure. This stops the piston movement of air-hydraulic cylinder *D*. He then measures compression on the workpiece. He then starts air-hydraulic piston forward by again shifting handle of valve *C* to increase operating pressure in the hydraulic circuit. When desired pressure is reached he again shifts handle of valve *C* into neutral and checks the compression on workpiece. This process is continued until the air-hydraulic piston reaches end of its stroke and all measurements are recorded.

Operator then shifts handles of both valves to their other operating positions and pistons of both cylinders retract, reducing operating pressure in the hydraulic system and releasing workpiece. The advantage of this layout is that an infinite number of readings may be taken along the travel of the air-hydraulic cylinder and when all the readings are finished the relief valve pressure setting can be quickly dropped to the starting position.

To automate this setup would require different types of actuators for the valves. In this case, electrically operated controls would be ideal. Stopping of piston of cylinder *D* at different pressure settings and gaging could be done automatically and this data could be recorded automatically on a tape. The circuit would be rather complicated, but the designer must decide if the production requirements will warrent the expenditure necessary to accomplish more automatic operation.

Another instance where air pressure can be used advantageously in conjunction with hydraulics is to use air pressure to actuate a hydraulic valve. Here one has the advantage of the rapid movement of air and the exceptional force that can be created by hydraulic pressure. By using such actuation an air circuit can be interlocked with a hydraulic circuit, *Fig.* 25. In this arrangement the workpiece trips limit switch *LS*-1 which energizes solenoid *C* of valve *A*, shifting valve spool and directing air pressure to blind end of air cylinder *B*. Work is moved into work position. Air pressure builds up opening air sequence valve *E* and air flows to pilot connection *R* of valve *F*, rapidly shifting spool and directting oil to blind end of coining cylinder *G*. After

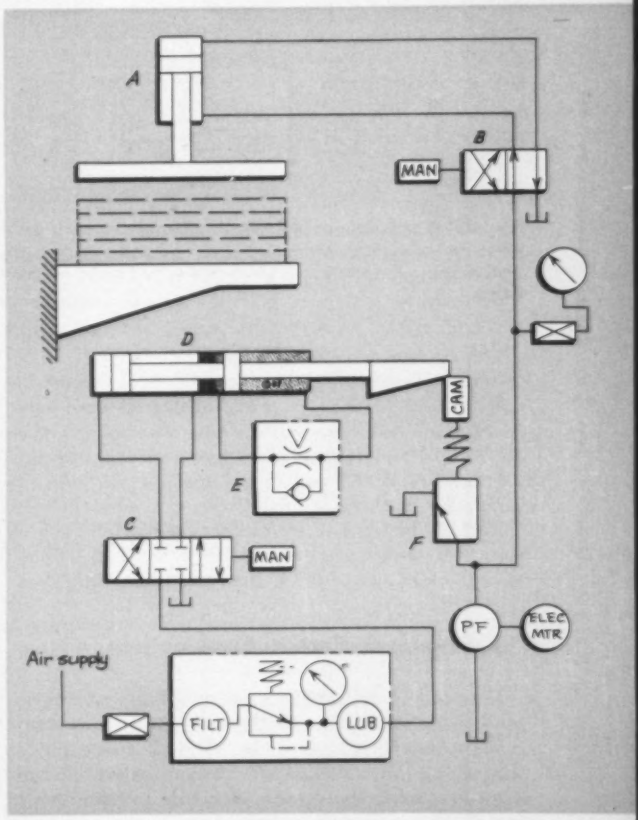


Fig. 24—Combination pneumatic-hydraulic arrangement provides control of relief valve settings in manual test cycle.

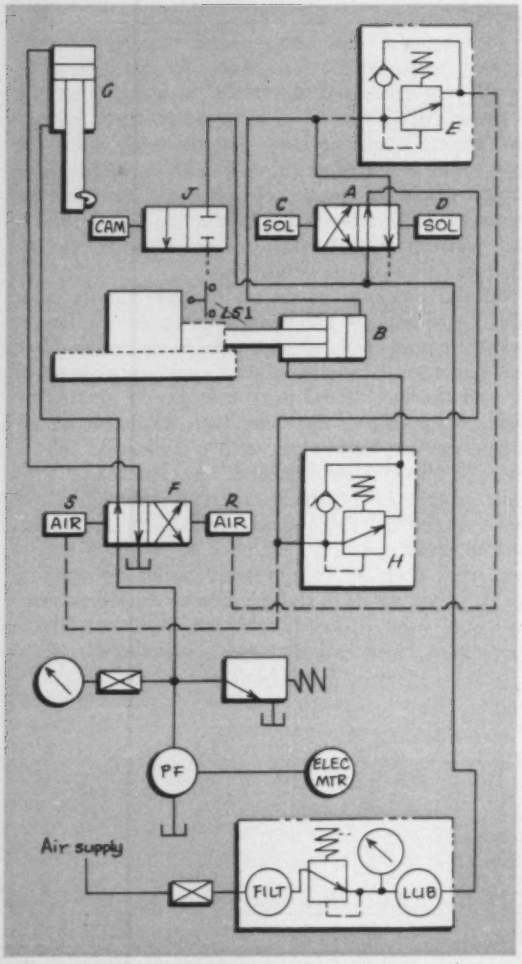


Fig. 25—Combination pneumatic-hydraulic circuit provides for pneumatic clamping and hydraulic coining of workpiece. Pneumatic pilots actuate hydraulic control valve.

coining operation has been completed a timer energizes solenoid *D* of valve *A*, shifting spool of valve to original position. Air flow is directed to pilot connection *S* of valve *F* and spool is shifted directing oil pressure to rod end of cylinder *G*. Air pressure builds up opening sequence valve *H* and clamp is retracted. Just before hydraulic ram reaches its fully retracted position an air blast valve *J* is tripped ejecting workpiece from fixture and completing cycle.

Pneumatic-Electric Combinations

While it is desirable to design a high production machine that will provide completely automatic cycling, one should not lose sight of the need for controlling the individual motions with manual controls during the set up period or in some emergency. Depending upon how complicated the nature of the setup is may govern how many of the individual motions want to be manually controlled during the setup period. Here are some of the things to take into consideration:

1. Should all motion immediately cease when one control is operated?

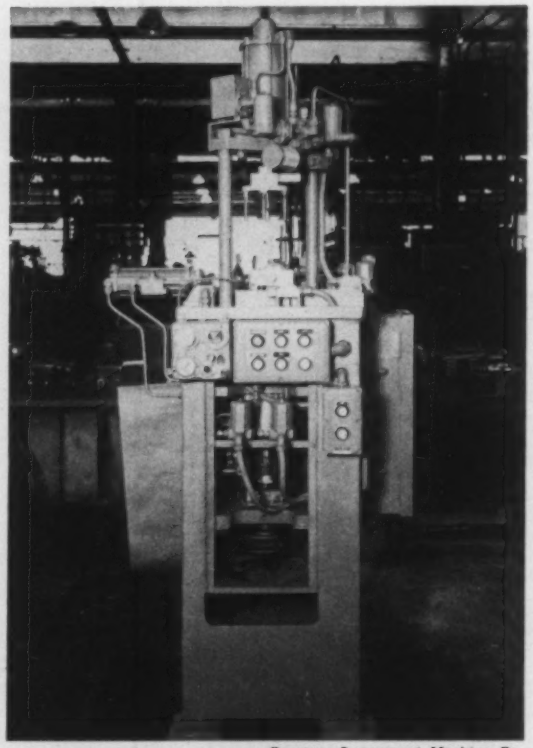
2. Should all movements be retracted to their starting positions and then halt?

3. Should movements be able to be retracted in reverse order of their advance?

4. Should the movement be stopped at the point of trouble, then when trouble is corrected be able to continue the automatic cycle?

It is almost mandatory to use electrical controls in some of the more complicated circuits. A case in point is a special drilling machine, *Fig.* 26. Simplified pneumatic and electrical circuits are shown in *Fig.* 27.

In this circuit a pallet bearing the workpiece trips limit switch *LS*-1, which momentarily energizes coil *A* of solenoid operated four-way valve *B*. Spool shifts and air is directed to blind end of injector transfer cylinder *C*. Piston of cylinder *C* moves forward and pallet and workpiece are moved into the clamping location at a speed controlled by flow control valve *D*. At end of stroke limit switch *LS*-2 is contacted which energizes solenoid *E* of four-way valve *F*. Spool shifts directing air to blind end of clamp cylinder *G*. When clamp is effected pressure builds up closing pressure switch *PS*-1, which causes



Courtesy Logansport Machine Co.

Fig. 26—Special drilling machine uses pneumatic cylinders to inject workpiece, clamp it, and eject it in an automatic cycle where work is performed by Hause Holematic unit which bores and countersinks.

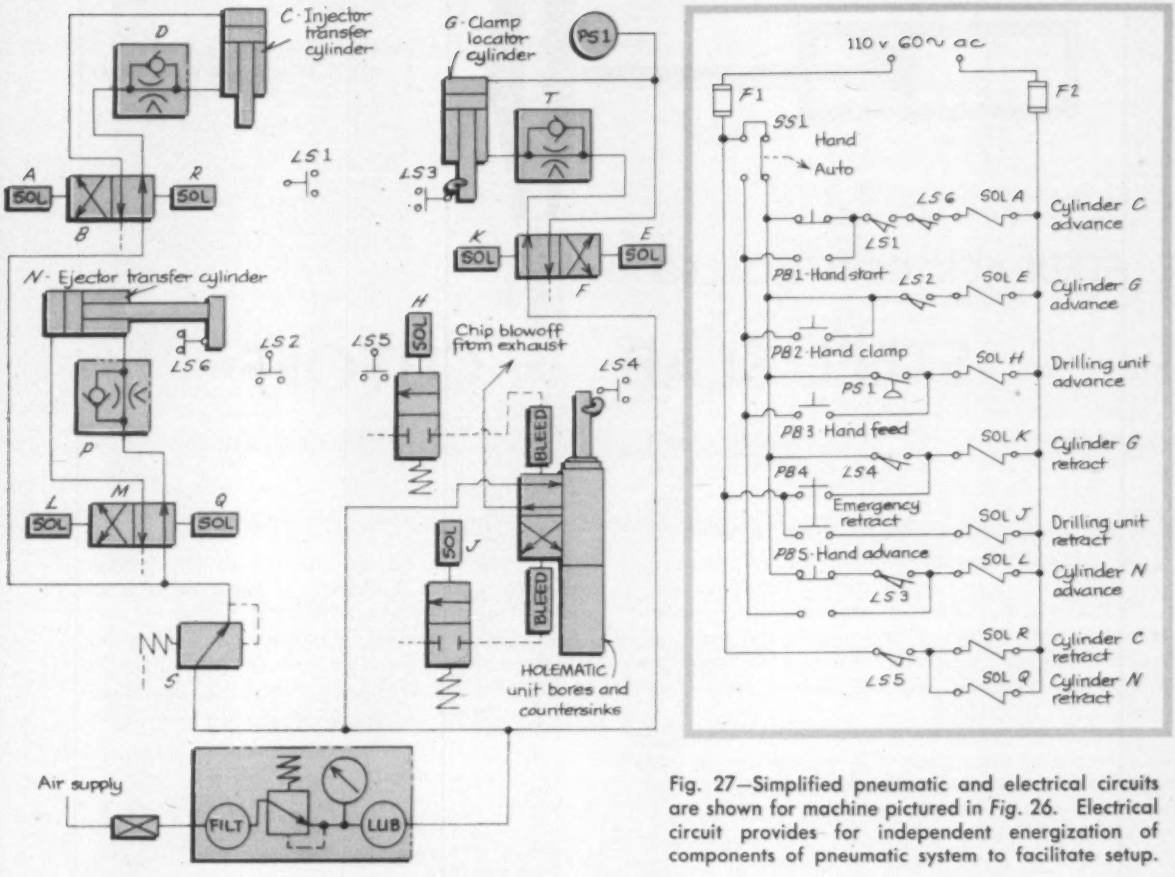


Fig. 27—Simplified pneumatic and electrical circuits are shown for machine pictured in *Fig.* 26. Electrical circuit provides for independent energization of components of pneumatic system to facilitate setup.

coil of two-way valve *H* to be energized opening valve and causing spool of four-way valve in drill unit to shift. This directs air pressure to blind end of drill unit and piston of drill unit moves forward at a speed set by choke valve in oil section of the unit.

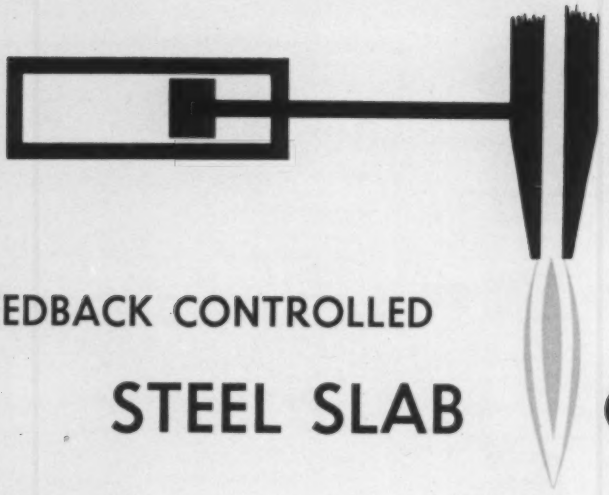
As operation is completed a poppet is tripped and causes valve of drill unit to shift to its original position and air pressure returns piston of drill unit to orginal position. Here limit switch *LS*-4 is contacted which energizes solenoid *K* of four-way valve *F*. Spool shifts and air pressure is directed to rod end of clamp cylinder *G* and clamp is retracted. Limit switch *LS*-3 is contacted energizing solenoid *L* of four-way valve *M*. Valve spool shifts and air is directed to blind end of transfer cylinder *N* and piston moves out ejecting pallet. At end of stroke limit switch *LS*-5 is contacted and solenoids *Q* and *R* are energized causing a shifting of the spools in valves *M* and *B* and the pistons of cylinders *N* and *C* are retracted to starting position. Limit switch *LS*-6 must be closed before a new cycle can start, which is a safety measure to make certain that the piston rod is out of the way before the next pallet is brought forward.

In setting up this machine switch *SS*-1 can be set at "*Hand*" and pushbutton *PB*-1 can be depressed to start the motion of cylinder *C* forward so as to check speeds and clearances. After cylinder *C* is set the clamping cylinder can be positioned to check location and clamping action. Pressure switch *PS*-1 will not cut in as there is no current now to the pressure switch. To bring the drilling unit into action *PB*-3 can be contacted. After drilling it will automatically retract when its trip is made. The trip can be set for different depths. If it is desired to check the drilling unit without the clamp in action and no workpiece in the machine *PB*-3 is pushed, and if the unit is to be retracted before the automatic trip takes place, *PB*-4 is pushed and solenoid *J* will be energized. The valve in conjunction with the drill unit will cause the piston of the drill unit to retract.

In order to move out the piston of ejection cylinder *N*, depress pushbutton *PB*-5 and this will energize solenoid *L* of valve *M*.

In circuits where it is necessary to use a different operating pressure (lower) than that set by the pressure regulator in the main circuit line, the insertion of a pressure regulator, as shown as valve *S* may be used. In this circuit the transfer cylinders require very little power but the clamp cylinder and drill cylinders require the full line pressure.

Use of combined pneumatic-electric circuits provides the designer of automated production machines with a versatile means of achieving automatic cycles.



FEEDBACK CONTROLLED STEEL SLAB CUTOFF

By T. FILMER and C. C. ROBERTS
Askania Regulator Co., Chicago, Ill.

CUTOFF operations using torches are employed in many manufacturing processes, particularly those found in the basic metal industries. It is often necessary for economic and technical reasons that these processes operate continuously, and in such cases the use of equipment for cutting "on-the-fly" is indicated.

Such an arrangement is used at the Welland, Ont., plant of Atlas Steels Ltd. for cutting off sections of steel slabs that descend continuously from a casting machine. The casting installation was described in detail in an earlier issue of AUTOMATION.*

Actually, squarely cutting off sections of desired length from a moving steel slab can present some rather complex control problems. In the Atlas installation, for example, the cutoff mechanism, *Fig.* 1, which uses two torches, requires a control system that meets the following specifications:

1. To obtain a square cut it is necessary that the frame carrying the cutting torches move down with the slab as the cuts are made.
2. Since slabs of high-speed, stainless, alloy, and tool steel in various thicknesses are cast on the machine at different rates, the torch feed rates across the slab must be adjustable.
3. Two feed rates are required for each torch—a relatively slow initial feed is used while the slab heats up and a faster feed is used for the remainder of the cut.

Torch Feed Control

The torch feed control system, developed by Askania Regulator Co., meets the requirements for a flexible unit that can be adjusted to suit process conditions, and is an example of the combining of several automatic control techniques.

The basic hydraulic, pneumatic, and electrical circuits for feed control of one cutting torch are represented schematically in *Fig.* 2. In operation, speed commands for the torch cylinder are preset

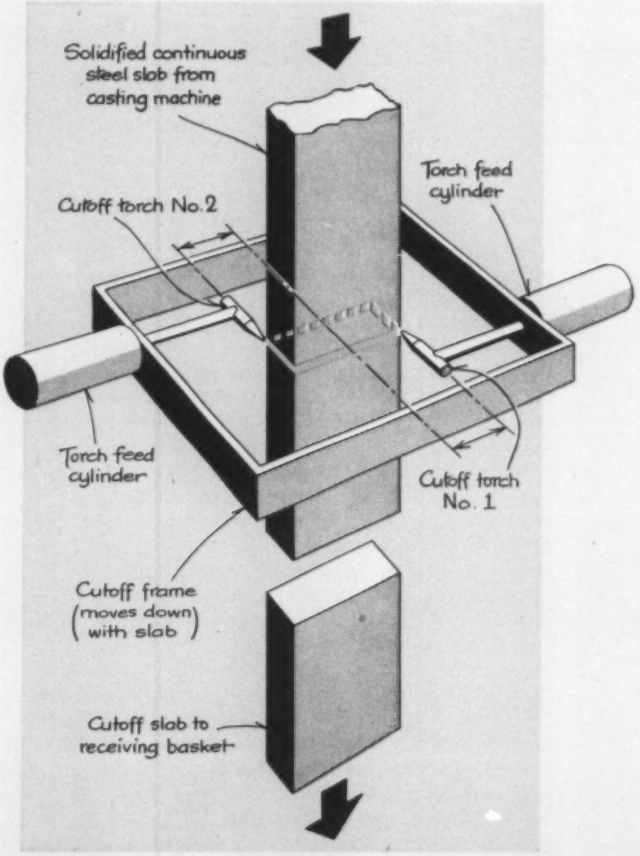

Solidified continuous steel slab from casting machine
Torch feed cylinder
Cutoff torch No. 2
Torch feed cylinder
Cutoff torch No. 1
Cutoff frame (moves down with slab)
Cutoff slab to receiving basket

Fig. 1—Cutting off sections of steel slab from continuous casting process is accomplished with this torch cutoff mechanism. Two torches are advanced from opposite sides and faces of slab to its center. Frame carrying torches and feed cylinders is moved down with the slab as cuts are made.

*"Steel Casting Process Has Centralized Control Of Process Variables," AUTOMATION, Vol. 4, No. 8, August 1957, pp. 60-62.

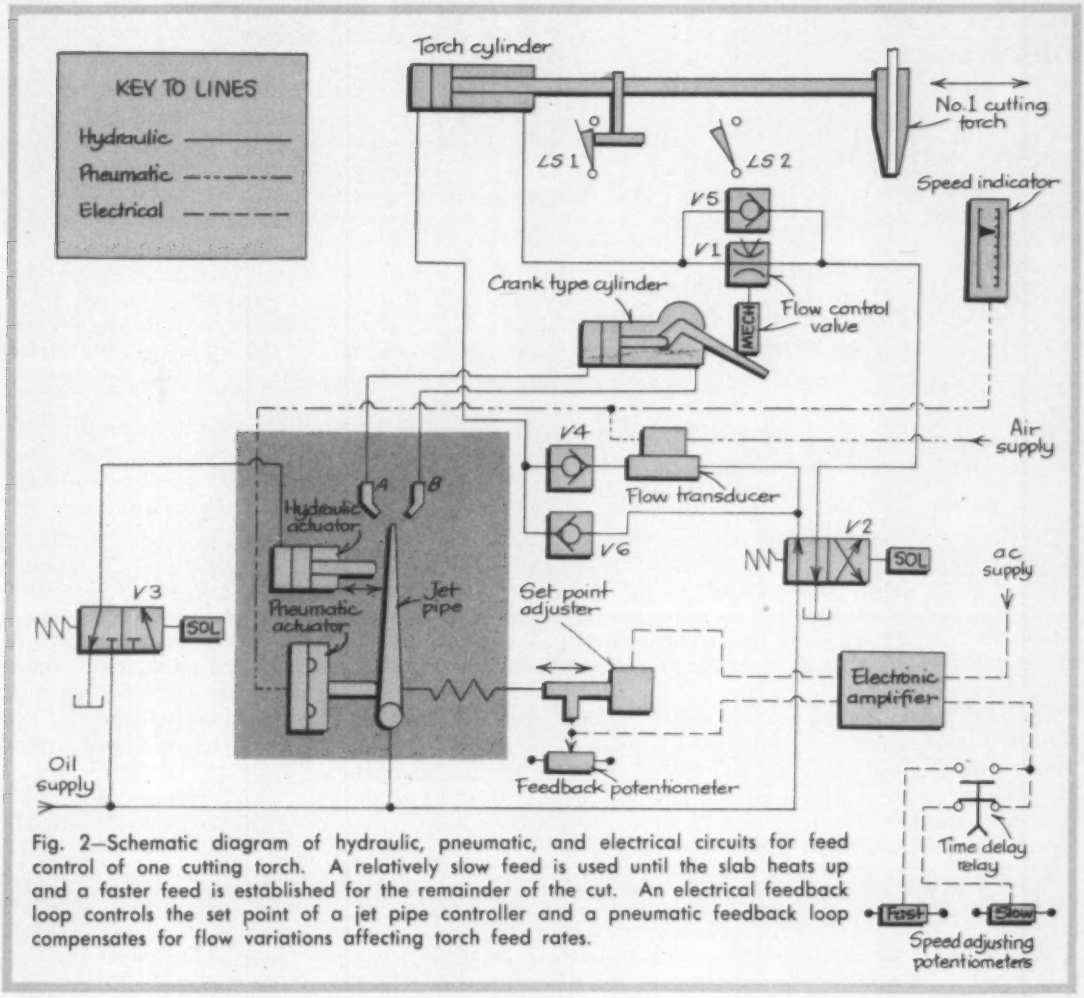


Fig. 2—Schematic diagram of hydraulic, pneumatic, and electrical circuits for feed control of one cutting torch. A relatively slow feed is used until the slab heats up and a faster feed is established for the remainder of the cut. An electrical feedback loop controls the set point of a jet pipe controller and a pneumatic feedback loop compensates for flow variations affecting torch feed rates.

on two speed adjusting potentiometers that are calibrated in terms of cylinder feed in inches per minute. One of these potentiometers controls the slow speed and the other the fast speed of the torch. Initially, the slow speed potentiometer is connected in the circuit of an electronic amplifier. After a preset time interval established by a time delay relay, this unit is automatically switched out of the amplifier circuit and the fast speed potentiometer is connected.

▶ Electrical Feedback Loop

In an adjustment of the slow feed the output of the amplifier, in response to the setting of the slow speed potentiometer, activates a small electric set point adjuster for a jet pipe controller. As the set point adjuster moves it varies the setting of a feedback potentiometer. An electrical signal from this potentiometer is fed back to the amplifier input where it is compared with the signal preset on the slow speed potentiometer. When the signals from these two potentiometers balance, output from the amplifier ceases and the set point adjuster stops.

When the fast speed potentiometer is in the amplifier circuit, its preset signal is also balanced out by a signal from the feedback potentiometer, but at a position of the set point adjuster corresponding to the fast speed potentiometer setting. There is thus a positive position of the set point adjuster for each setting of the speed adjusting potentiometers.

Changes in the position of the set point adjuster act through a spring to deflect the jet pipe to different positions with respect to two spaced receiving orifices. The spring forces developed by the set point adjuster are opposed on the other side of the jet by forces developed by a pneumatic actuator. The operation of the latter device will be described later.

The pressure developed at each orifice is a function of the distance of that orifice from the nozzle of the jet pipe. Assuming the jet pipe has been positioned by the set point adjuster so that its nozzle is closer to orifice *A* than *B*, *Fig.* 2, the pressure at *A* will be greater than that at *B*. This will cause the crank type cylinder to be actuated in a direction to open mechanically operated flow control valve *V*1 by a preset amount. This action serves to provide a restricted path for oil to flow from the

rod end of the torch cylinder to tank through directional control valve *V*2.

Since system pressure is applied to the blind end of the torch cylinder through *V*2, the flow measuring section of a flow transducer, and check valve *V*4, the piston of the torch cylinder will extend. Its speed is governed by the amount *V*1 is opened by the crank type cylinder, which in turn depends on which feed potentiometer is connected in the amplifier circuit and its setting.

Pneumatic Feedback Loop

The function of the flow transducer is to measure the flow of oil entering the blind end of the torch cylinder during its feed stroke and to generate pneumatic feedback signals representative of the flow. A rotating, positive displacement meter in the flow transducer measures oil flow and another section of the unit provides pneumatic signals proportional to the square of the flow.

These pneumatic signals are applied to the diaphragm of the pneumatic actuator previously mentioned, which is a part of the jet pipe controller. The purpose of these signals is to compensate for flow variations that affect torch feed. If, for example, flow should increase above the set point, the change will be reflected in a strong pneumatic feedback signal that will cause the pneumatic actuator to move the jet pipe away from orifice *A* and toward *B*. This will change the position of the crank cylinder in a direction to decrease the flow through *V*1. If the flow should decrease below the set point, the pneumatic feedback signals will automatically compensate by causing an increase in the flow through *V*1.

Limit Switch Control

When the piston of the torch cylinder extends, a stop on the piston withdraws from limit switch *LS*1, allowing this switch to close. When the piston is fully extended, the stop on the piston closes normally open limit switch *LS*2.

Closing of *LS*2 causes energization of the solenoids of directional control valves *V*2 and *V*3. When the solenoid of *V*2 is energized the spool of this valve is shifted to a position directing oil to the rod end of the torch cylinder through check valve *V*5 and connecting the blind end of the cylinder to tank through check valve *V*6. This causes the piston of the torch cylinder to retract.

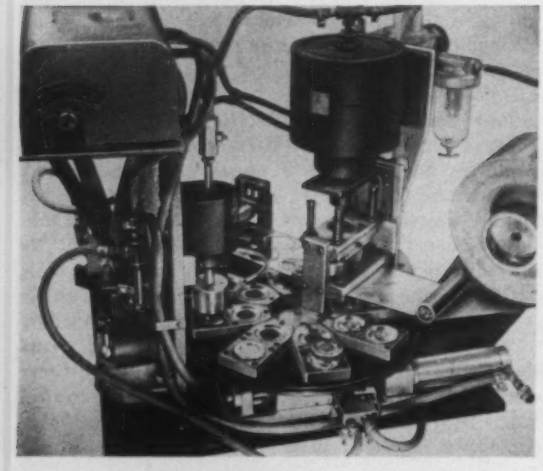
Energization of the solenoid of directional control valve *V*3 causes the spool of this valve to shift to a position directing oil to the blind end of a hydraulic actuator associated with the jet pipe controller. When the piston of this actuator extends it contacts and moves the jet pipe in the direction of orifice *B* so that the crank cylinder will close flow control valve *V*1 in readiness for the next cutting cycle.

As the piston of the torch cylinder reaches its fully retracted position the stop on the piston opens limit switch *LS*1. This breaks the holding circuit for the solenoids of directional control valves *V*2 and *V*3 and the spools of these valves are shifted to their original positions.

Shifting of the spool of *V*2 restores the pressure path to the blind end of the torch cylinder through the flow transducer and check valve *V*4. Shifting of the spool of *V*3 connects the blind end of the hydraulic actuator to tank and allows its piston to be retracted away from the jet pipe by a return spring in the actuator. One torch cylinder cycle is thus completed.

This system illustrates the fact that effective control of complex actions may involve use of all three major types of control components—hydraulic, pneumatic, and electrical.

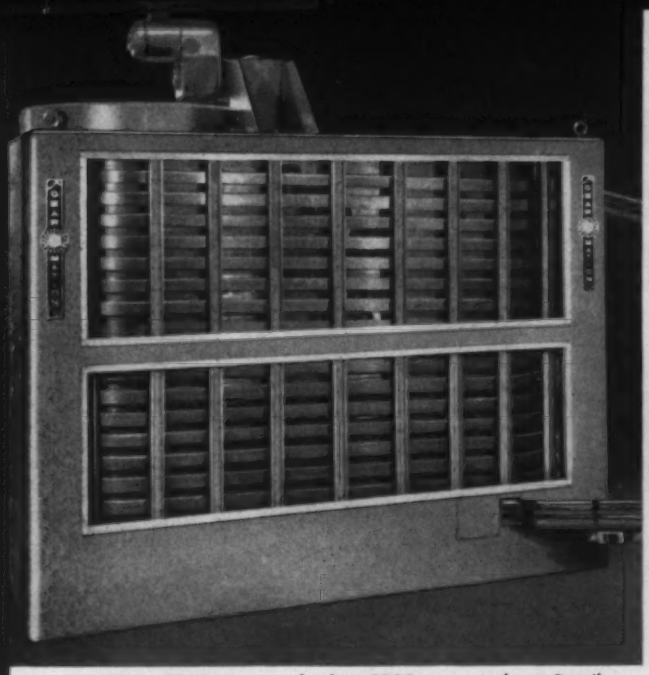
packaging machine built from standard components



SEMIAUTOMATIC packaging machine which makes and seals small aluminum "pill box" type containers has been designed and built by J. B. Morrison Co. Ltd. of Toronto, Canada.

Roll of aluminum foil at right is fed through dies by a pair of rollers at the left rear of the device. Single-acting air cylinder actuates a die set to punch out and form top and bottom pieces of container in one stroke. Table then rotates clockwise to operator loading station. Merchandise is placed in one container shell and other shell is placed on top to complete package. Table then rotates under air press at left where two shells are pressed together and sealed. Completed unit is ejected from device by air blast at subsequent station.

Packaging unit uses standard components manufactured by Mead Specialties Co.



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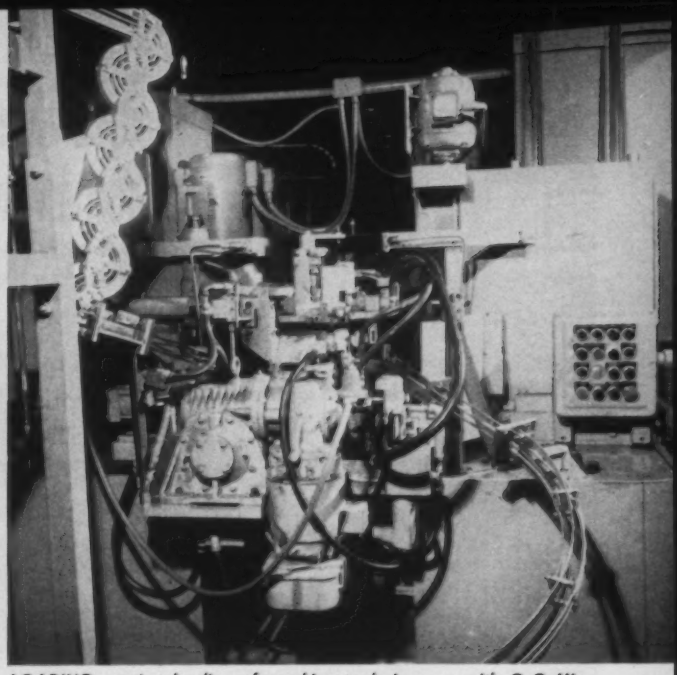

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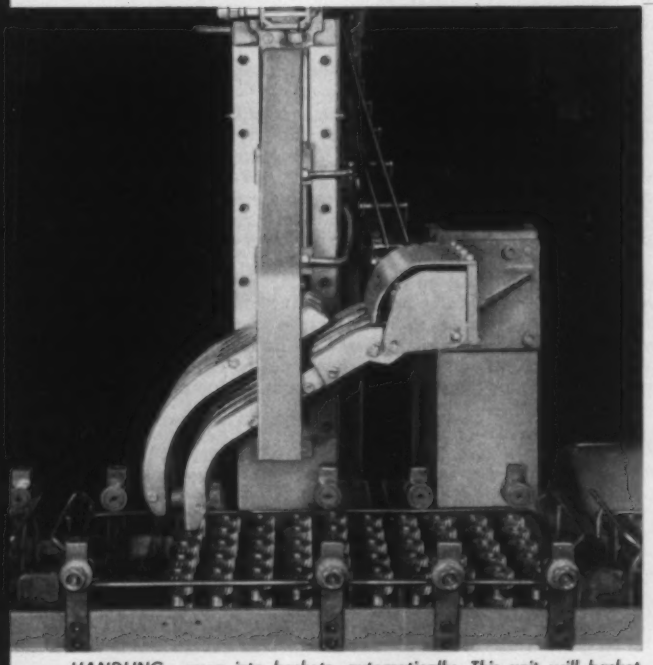

HANDLING—even into baskets, automatically. This unit will basket load 3000 parts an hour for conveyor transfer. Send for Bulletin 568.

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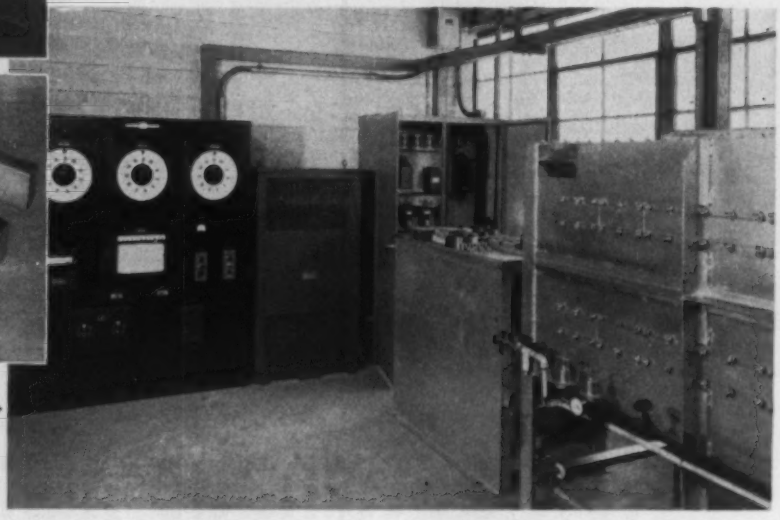

REED ROLLED THREAD DIE COMPANY GETS . . .

George W. Lyman, Chief Engineer

- "Uniformity of Austenitizing Cycle,
- Absolute Control of Surface Chemistry,
- Minimized Handling Damage"

The Reed Rolled Thread Die Company of Holden, Mass., recently installed a Hayes LAC furnace equipped with Hayes Ampro process atmospheric control to heat treat their flat, cylindrical and planetary thread rolling dies made of high carbon-high chrome steel.

Uniformity of the austenitizing cycle, absolute control of the thread surface chemistry, and reduced possibility of damage to the thread crests of the dies are the outstanding features which led to the selection of Hayes equipment and process.

Temperature in the three zone heating and the water-jacketed cooling sections of the furnace is closely controlled. Scaling of the dies has been eliminated, and the carbon content of the die surfaces is controlled by using dew point measurements to regulate the proportions of dissociated ammonia and propane in the furnace atmosphere according to the Hayes formula. By heating and cooling in the same piece of equipment, objectionable handling damage is minimized.

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AUTOMATION new equipment

Machines and plant equipment for more automatic operations

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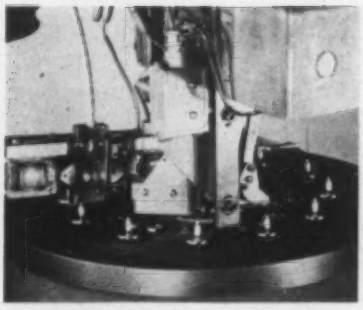


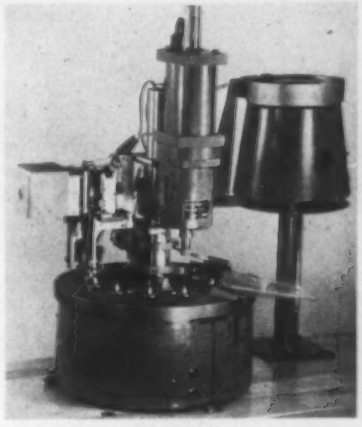
Needle Assembly Unit

AUTOMATIC machine to feed, assemble, and swage disposable hypodermic needles has been developed by **Black & Webster Inc.**, 445 Watertown St., Newton 58, Mass. In operation, aluminum hubs are fed from a vibratory feeder, down a plastic feed tube, to an orienting mechanism and escapement. The hub is correctly positioned, dropped on an anvil, and carried to a cannula-feeding station. When the cannula is positioned in the hub, the parts are ready for swaging. The finished assembly is ejected automatically.

The hub orienting mechanism consists of a selecting station and two continuous-duty solenoids and is controlled by an indexing cam within the table. A removable plastic window on the side of the orientor provides access and visual inspection.

The cannulae with points all in one direction are loaded horizontally in a magazine. They are fed individually to the fingers of a positioning arm by a slide. The slide picks the bottom cannula from the magazine and delivers it to the fingers. The arm then turns the cannula 90 degrees to a vertical position, carries it down to the nest, and inserts it in the hub. The fingers open and the arm returns to its *Up* position.

When the hub and the cannula are in position on the anvil, they are swaged by an impact tool that gets power from a dc solenoid. The



impact tool is actuated by the indexing cam in the table and is synchronized with it. The table must be locked and come to a stop before the punch operates. Finished needle assemblies are ejected automatically at the next station. The entire machine has a series of safety interlocks which stop the operation if a defective part is fed to it.

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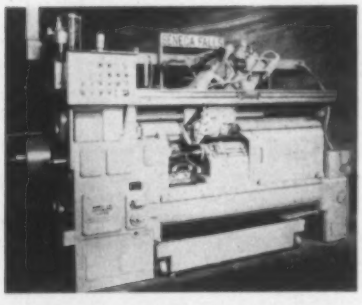

Automatic Lathe

Item 402

Machine is designed to automatically rough and finish turn shafts without removing the workpiece from the centers between the two operations. The roughing operation is accomplished with multiple tools mounted on a rear carriage, while finish turning is done with single point tracer-controlled tools on one or more overhead carriages. Close tolerances are maintained since the pressure of the single point tracer-controlled tools is constant over the entire length of the workpiece.

In operation, shafts are loaded between centers and the operator pushes the *Start* button. The multiple tools rough-turn the work, then retract. The tracer-controlled tools then finish-turn and retract to the starting position when the spindle stops revolving.

Model Q features double headstock speed and carriage feed ranges —one for roughing and one for finishing. The tracer unit includes four components: A measuring device or stylus, an electric amplifier, a controllable mechanical power amplifier for positioning the cross feed slide, and a master template. The tracer carriage has a forward and reverse rapid traverse for the tracer slide which reduces idle time to a minimum. The rapid traverse movement is independent of the tracer system and is operated through pneumatic clutches and contactors mounted on a control drum. **Seneca Falls Machine Co.**, Seneca Falls, N. Y.

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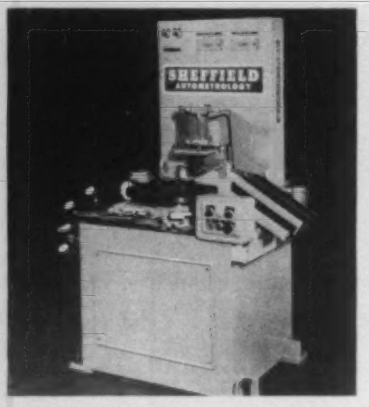


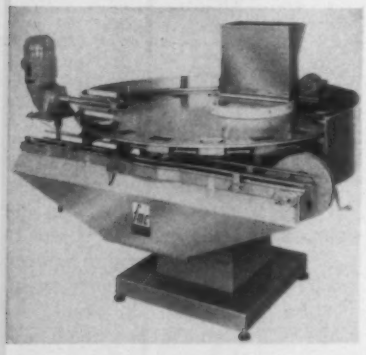
Leak Checker

Item 403

Automatic gaging and segregating machine inspects automobile thermostats for seal leakage on a production basis. Test is given under a pressure condition simulating that in an automobile cooling system. The seal leakage test performed under four pounds air pressure is designed to measure water seepage rate through a closed thermostat.

The gage checks up to 1500 thermostats per hour and segregates them into leakage classifications of zero to 0.2 gpm or 0.2 to 0.3 gpm. Automatic counters tally each class. Parts which do not fall into either class are ejected down a chute. **Sheffield Corp.**, Box 893, Dayton 1, Ohio.

Circle 403 on Page 127



Carton Filler

Item 404

Machine, designated Model 16S, is designed for filling frozen food cartons at speeds up to 240 cartons per minute (retail size), and 110 cartons per minute (institutional size). In operation, a normally straight-line feed curves slightly at the filling station to permit adequate time for the premeasured product to enter the carton. No transfer disc is needed. Cartons are advanced by means of a lug-chain conveyor that is synchronized with the pocket spacings of the filler. After filling, the cartons are conveyed to a closer.

One of the features in the machine is a *no carton-no fill* device that prevents discharge of the product from the machine unless a carton is properly positioned under the pockets. The pockets can be adjusted to meet a variety of volume requirements. Individual pocket cut-off gates prevent product damage and build-up. They also permit closer tolerances at the bottoms of the pockets, providing greater filling accuracy. **Canning Machinery Div., Food Machinery & Chemical Corp.**, P. O. Box 1120, San Jose, Calif.

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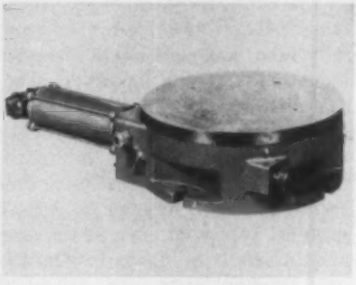

Rotary Indexing Table

Item 405

Table is designed so that it can be set or adjusted to any number of indexes from 4 to and including 24. An adjusting screw at each station can change the locked position of an individual station from zero to 15 degrees from its original location. An arrangement is provided which makes it possible to skip 1, 2, 3, or 5 stations on each indexing motion. With the skip-station arrangement and the individual station adjustment feature, any desired pattern that requires from 4 to 24 stations can be set up. Once the table has been adjustd to a particular pattern, it will repeat that pattern until readjusted. The table is available in a 12-inch, 24-station model for either air or hydraulic operation. **Savage Engineering Div., Lithibar Co.**, 345 W. 14th St., Holland, Mich.

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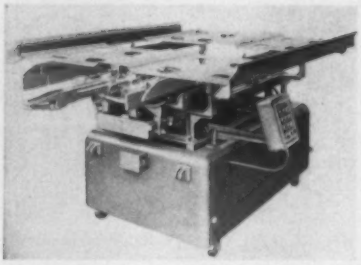

Press Loader/Transfer

Item 406

Portable unit automatically loads and unloads parts in and out of dies in any type of punch press and transfers parts between presses. When the loader is placed in front of or behind each punch press, an automatic punch press line is set up, and up to 18 pieces per minute can be produced.

Dies can be quickly unloaded on the upstroke of the press and reloaded on the downstroke. Transfer rails or jaws lift the part from one die, index it on equidistant centers to the next press and place the part in the next die. Tooling can be adjusted to handle a number of different parts over the same line. Electrical interlocks prevent the press from completing a cycle if a die fails to release the part. **Die & Automation Inc.**, 5353 Dixie Highway, Hamilton, Ohio.

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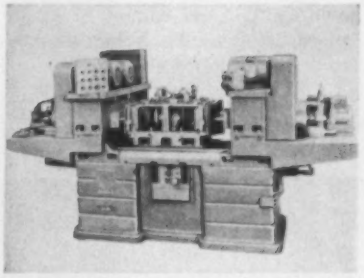

Cylinder Head Borer

Item 407

Automotive cylinder heads with concentric valve seats and guide holes are produced on Model 17-A. Machine cycle is completely automatic; the unit plunge-faces the intake and exhaust valve seats and drills the valve guide holes from the solid. Production rate is 23 cylinder heads per hour.

In operation, the cylinder heads are hydraulically clamped in a two-

compartment fixture mounted on the machine table. Moving in rapid traverse to the left, the table feeds in to four cutter-equipped spindles that plunge-face the intake valve seats. The table retracts slightly and four gun-type drills advance simultaneously through the spindle shafts and drill the valve guide holes from the solid. The table withdraws to the center position and the part is unloaded. Tolerance is held to 0.001-inch. During this operation, a second part can be loaded and clamped in the right-hand fixture compartment where exhaust valve seats and guide holes are produced. **Ex-Cell-O Corp.**, 1200 Oakman Blvd., Detroit 32, Mich.

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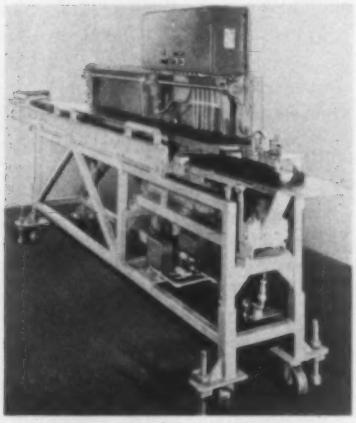

Strip Stock Feeder

Item 408

Portable, plug-in package unit is designed to handle heavy flat strip stock of thicknesses beyond the capacity of conventional roll feeds and straighteners. The feed unit can be adapted to presses using either single-operation or progressive dies. In operation, the strip stock is rolled into a preload station and automatically lowered to a feeding station by air-cylinder controlled arms. The sheet of strip stock is fed into the press by a reciprocating mechanism which has mechanical grippers. The stroke of the feed mechanism is adjustable for a variety of pressroom applications. The electrical controls can be tied into the press cycle to provide a fully automatic feeder arrangement. **Press Automation Systems Inc.**, 25418 Ryan Rd., Centerline. Mich.

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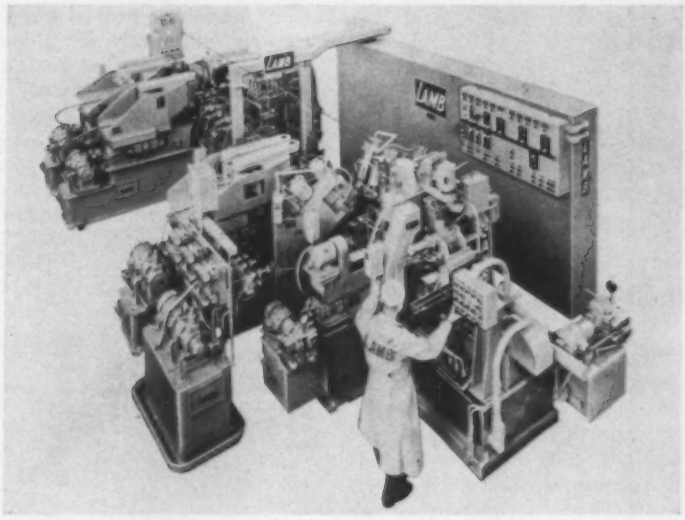


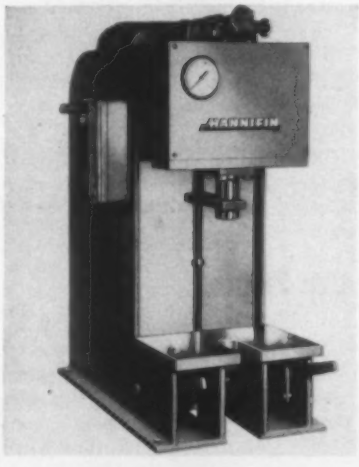
Transfer Machine for Automotive Pistons

Item 409

Equipment has 26 stations, is designed to process 450 pistons per hour. The machine receives turned and grooved pistons with their domes down. It tests radial position of the wrist pin hole and reorients the part when necessary. The machining operations include boring the wrist pin hole, drilling a processing hole in the balance bosses, drilling oil holes in the wrist pin bore, milling two slots, rough-milling two balance bosses, and rough and finish-milling two angular flats on the piston dome. The machine probes all drilled holes, gages all pistons, and marks rejected pistons.

Device uses standard hydraulic power units for milling, drilling, and boring operations. The transfer bar is a walking beam type, hydraulically actuated by two cylinders; one for horizontal motion, the second for vertical motion. A pendant-mounted master pushbutton control is located at the loading station. A schematic pilot light arrangement on the main control panel identifies each station and operation. The panel is interlocked to a predetermined sequence. If the sequence is broken, the machine stops and the lights indicate the trouble station. The gaging equipment stops the machine if three consecutive parts are out of tolerance. Lubrication is automatic and warning lights indicate lack of lubricant pressure. **F. Jos. Lamb Co.**, 5663 E. Nine Mile Rd., Detroit 34,

Circle 409 on Page 127



Hydraulic Press

Item 410

High-speed bench press is applicable for forming, trimming, and force-fit assembly operations. The return stroke, downstroke, and tonnage are adjustable. Stroke is 6 inches, reach from throat of frame to centerline of ram is 6 inches, and daylight opening is 12 inches. The removable table is 14½ inches wide by 10 inches deep, and its top is 8¼ inches above the mounting surface. Speeds of the press are: Down advance, 700 ipm; down feed, 330 ipm; and return, 670 ipm. **Machinery Div., Hannifin Co.**, Des Plaines, Ill.

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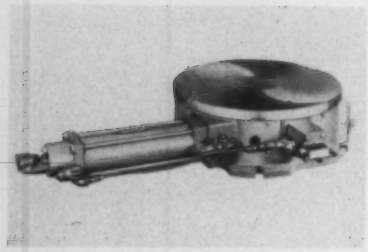

Air Index Table

Item 411

Device can handle work loads of up to 1 ton, can support repetitive shock loads radially and axially. When equipped for 6-station operation, Model 2400 can index 30 positions per minute, loaded. A 4-inch bore air cylinder, developing a power stroke nearly 13 times air line pressure, rotates the table. The indexing cylinder is controlled on its forward stroke by a positive, non-adjustable stop. An adjustable stop prevents overriding on the return stroke.

Table is locked in position within ±0.0015-inch by a separate air cylinder. The table top rotates on a tapered roller bearing on a center shaft, and is supported on its outer edge by 110 square inches of bearing surface. Unit operates on 60 to 175 psi line pressure, rotates clockwise, can be furnished for counterclockwise rotation. **Air-Hydraulics Inc.**, 609 Hupp Ave., Jackson, Mich.

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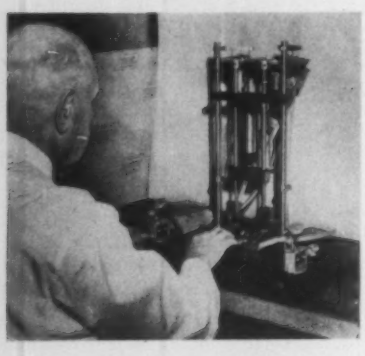

Automatic Screw Feeder

Item 412

Applicable in assembly operations, feeder fits all makes of pneumatic tools. Screw feeder can drive any type of headed screw, and works to tolerances such that screws can abut one another.

The collets on the unit are precision machined to hold screws accurately and firmly for finding of screw holes. Feeder can be attached to screwdrivers, nut runners, impact wrenchs, pneumatic cylinders, and electric drivers, and the assembly can be mounted on a balancer, on a lift table, or on a fixed position stand. **Zipp Screw Feeder Div., R. C. Neal Co. Inc.**, 76 Pearl St., Buffalo 2, N. Y.

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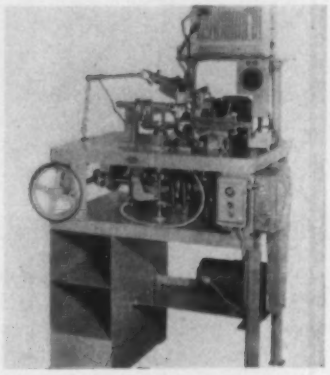

Diode Welding Machine

Item 413

Equipment is capable of feeding, cutting, forming, and welding a cat-whisker wire on beaded or unbeaded lead wires for small crystal diodes. Gold, tungsten, or molybdenum wire can be handled. Machine is designed for automatic loading and unloading, has a production rate of 3000 wires an hour. A synchronous electronic timer provides welding of uniform quality.

The forming tools, which form the wires in S or C-shape, are made of laminations to avoid intricate grinding operations. A six-position turret is indexed by a hardened and ground Geneva motion. The replaceable cutting tools have tungsten carbide inserts. All operating positions are accessible for maintenance. **Kahle Engineering Co.**, 1400 Seventh St., North Bergen, N. J.

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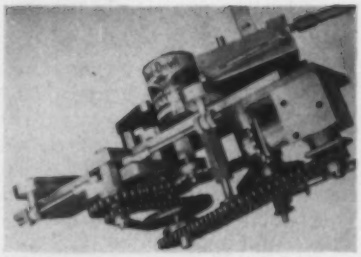
Can Printer

Item 414

Suitable for use on paint, oil, food, and similar type cans, marker uses flexographic printing for contents, flavors, colors, viscosity, and batch identification. A handwheel



adjusts the printing head for different can sizes and circumferences. Printer is adjustable through a full range of sizes from 3 to 6 inches in diameter.

As the container is positioned beneath the filling station, a roller-bearing equipped cradle engages the can. The printing drum is moved into contact, rotating and imprinting the can and releasing it for the next cycle. Interchangeable rubber printing dies are molded in one continuous length for marking standard one-gallon containers. Duplication and overprinting on smaller sizes is prevented by using die strips of the proper length and camming away the printing drum at proper time. **Industrial Marking Equipment Co. Inc.**, 454 Baltic St., Brooklyn 17, N. Y.

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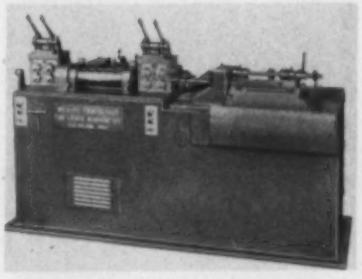


Rod Cutting Machine

Item 415

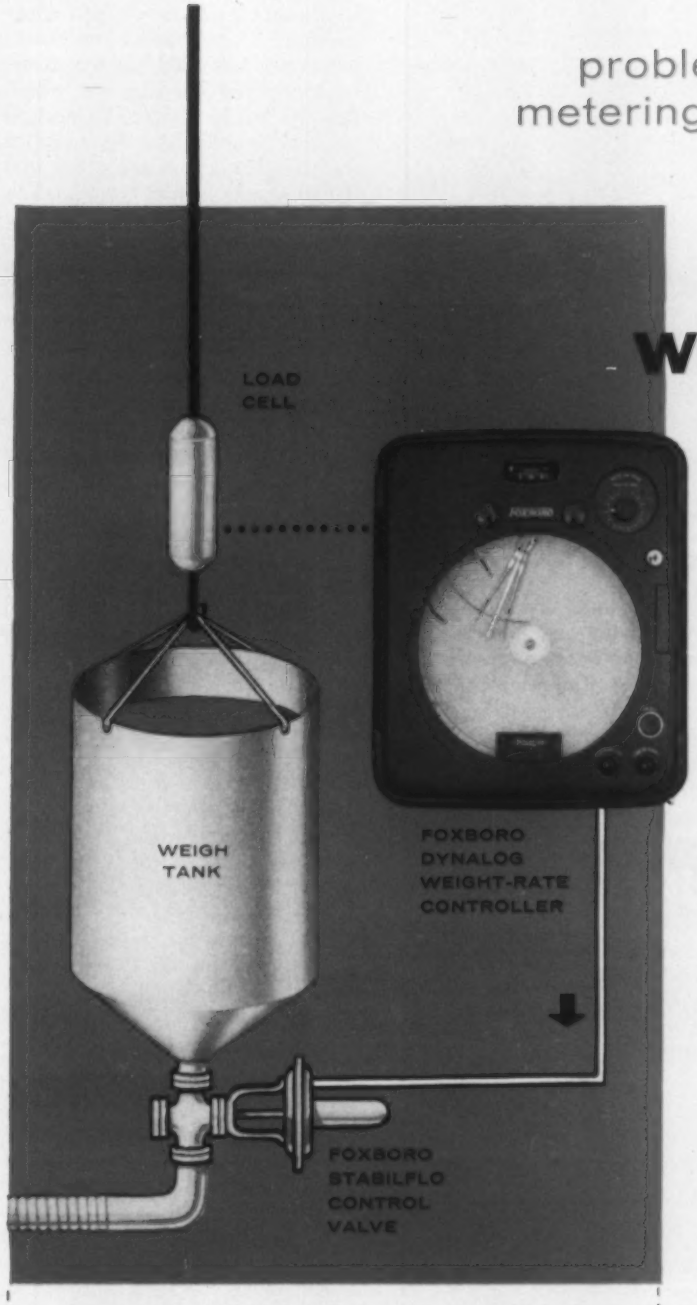
Device is capable of high-speed cutting of commercial welding rod and similar items. Feed speeds from 75 to 520 fpm are possible. The cutoff, which travels with the rod and cuts while in motion, is suitable for either long or short lengths. With an air clutch, synchronization of the cutoff and wire speeds is attained in the range of 125 to 395 fpm. Without the clutch, higher rates of production are possible, as for cutting short items. **Lewis Machine Co.**, 3441 E. 76th St., Cleveland 27, Ohio.

Circle 415 on Page 127

problem of
metering "tricky" liquids
eliminated!

Foxboro WEIGHT-RATE SYSTEM

accurately controls flow rate of any liquid that will pass through a pipe



HOW IT WORKS The Foxboro Weight-Rate Flow Control System controls weight of liquid passing from a weigh tank suspended from a load cell (either hydraulic or strain gauge-type). Cell continuously measures decreasing weight of liquid. Controller records weight, controls time of draining, and sends pneumatic control signal to a Foxboro Stabilflo Valve installed in drain line. After correct amount of liquid is taken from tank in the desired time, controller automatically closes valve.

Here's a Foxboro batch control system designed especially for liquids that undergo wide fluctuations of density or viscosity, or for liquids at high temperatures. Small volumes, corrosive liquids — even liquids that stick to the side of a tank will not affect the system's accuracy.

The Foxboro Weight-Rate System controls flow rate by weight of liquid rather than by volume. Functions of a load cell; a Dynalog* electronic recorder; and a Cyclelog* pneumatic controller are coordinated to do this.

Operation is simple. You merely set weight of liquid, dial the desired time, and push a button. The automatic control system does the rest, while keeping an accurate record of the whole process.

Best of all, the Foxboro Weight-Rate System requires practically no maintenance. That's because neither the measuring element nor the controller ever come in contact with the process liquid.

If batch operations with "tricky" chemicals are your problem, Foxboro has the answer. Call your local Foxboro Field Engineer for full details, or write **The Foxboro Company, 127 Norfolk Street, Foxboro, Mass.**

*Reg. U.S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF.
FLOW CONTROL SYSTEMS

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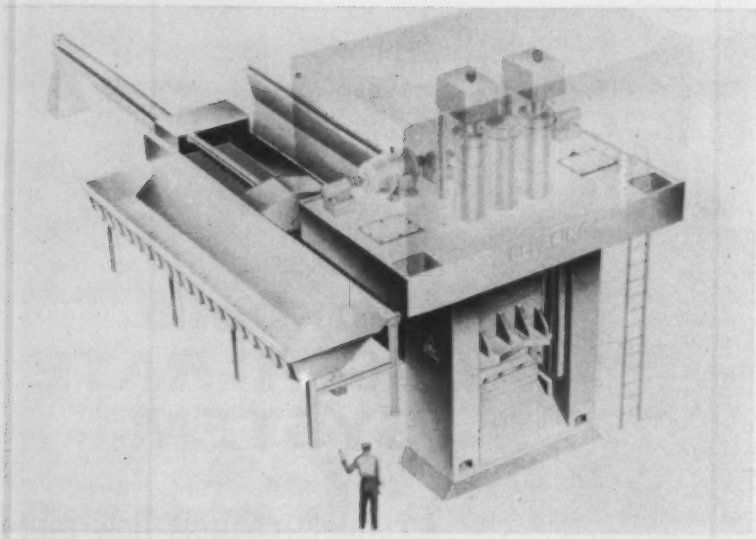

Automatic Hydraulic Scrap Shear

Item 416

Machine is hydraulically operated and equipped with a hopper and charging box for continuous operation. Working mechanism is waterproofed for outdoor use. Shear blades are adjustable to compensate for wear, and will cut heterogeneous scrap steel to meet specifications of consuming mills and foundries. It can develop 600 tons pressure and cut up to 30 tons of scrap per hour.

In operation, the feed hopper is loaded with scrap and tilted by hydraulic cylinders to dump the scrap into a charging box. A hydraulic ram operates through the charging box, pushing the scrap into shear position. The stroke of the charging ram is adjustable in 6-inch increments from 6 to 48 inches, which provides for the scrap to be cut into uniform lengths. As the scrap in the charging box is being fed into the shear, the hopper is reloaded to provide a nearly continuous flow of material through the machine. To accurately position the scrap for shearing, the unit has a hydraulic hold-down device. Designed by **Clearing Machine Corp.**, Chicago, Ill., the shear is distributed by **Consolidated Mill Supply Co.**, 5843 S. Loomis Blvd., Chicago 36, Ill.

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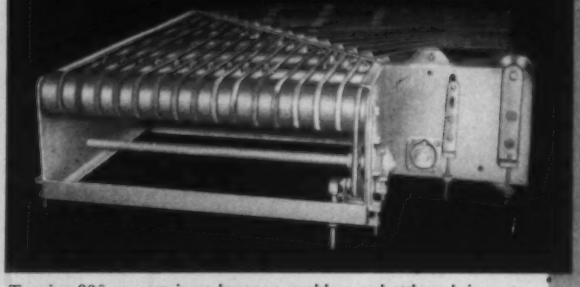
NEW STEWART-TURN
the 90° turn that really works!

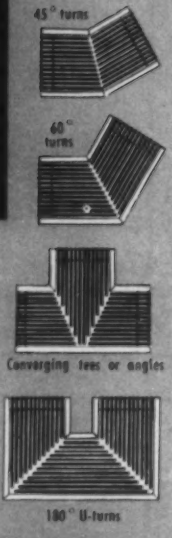


Turning 90° corners is no longer a problem or bottleneck in material handling systems. The unique Stewart-Turn moves material around corners as easily as in a straight line! No rollers to stick, tight corners to jam or deflectors to damage the material being moved. Never before has this been possible!

The Stewart-Turn is a series of narrow-faced belts, running in grooved pulleys, banked for constant contact with the material in motion. A slight differential in speed between the bank of belts produces a positive turning action, with belts spaced to carry small as well as large or long articles. Belt friction reaction to turning has been eliminated.

Stewart-Turns, as well as all Stewart-Glapat material handling equipment and conveyors, are CUSTOM DESIGNED TO YOUR JOB. If you are looking for advanced engineering thinking for your material handling or automation problems, WRITE STEWART-GLAPAT TODAY, and ask for complete details on the sensational, new Stewart-Turn!

A few other applications of versatile Stewart-Turns.



STEWART-GLAPAT Corporation
1645 Moxahala Avenue, Zanesville, Ohio

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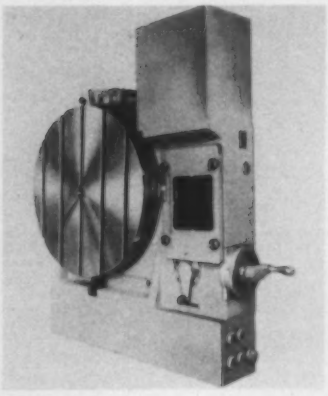

Rotary Table

Item 417

Adaptable to milling, drilling, and boring machines, motorized rotary table is also suitable for operations that require automatic indexing. To operate, the motor-driven unit is plugged into an electrical outlet; it requires no connection to a supporting machine. Normally used in a horizontal position, the table can also be used in a vertical position by mounting the four control buttons (*Feed, Rapid Traverse* in either direction, and *Stop*) in a separate panel on a pedestal. The machine can be equipped with automatic positioning and automatic milling cycle controls. The table can handle work loads of 5000 lb; tables with increased work load capacities up to 50,000 lb are available. **W. B. Knight Machinery Co.**, 3920 W. Pine Blvd., St. Louis 8, Mo.

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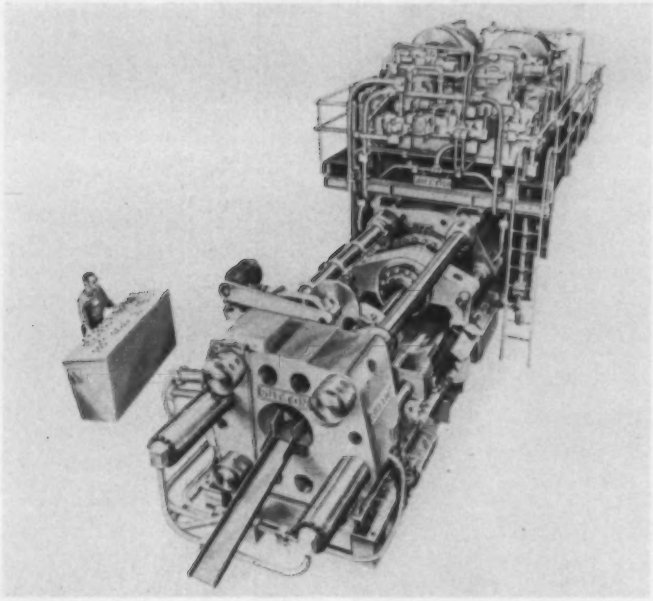

Extrusion Press

Item 418

Designed for high speed production of brass and other copper-alloy rods and shapes, extrusion press can operate at 90 ipm, with provisions for increase to 120 ipm. The operating cycle is controlled and the auxiliary motions of the press can be preset and automatically repeated. Press is designed with a lateral die slide and provides extrusion with a shell. The shell is removed by a gripper in the die slide and full length container-stripping cylinders. A scrap handling elevator picks up the shell after discharge and raises it to a separate dummy knocker press. The dummy knocker press has an anvil for dislodging the dummy block. With a parallel second cylinder platen, the anvil crushes the shell to reduce storage space and scrap handling time. **Sutton Engineering Co.**, First National Bank Bldg., Pittsburgh 22, Pa.

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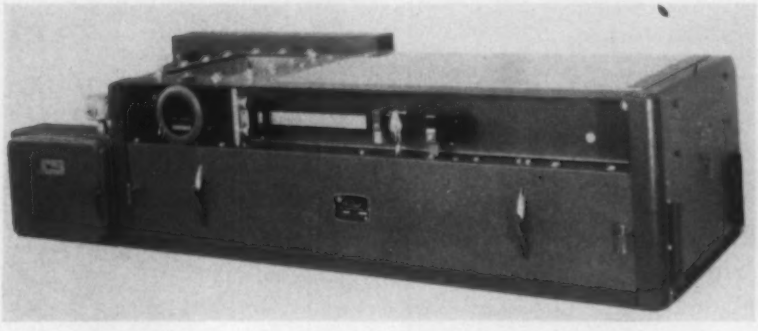


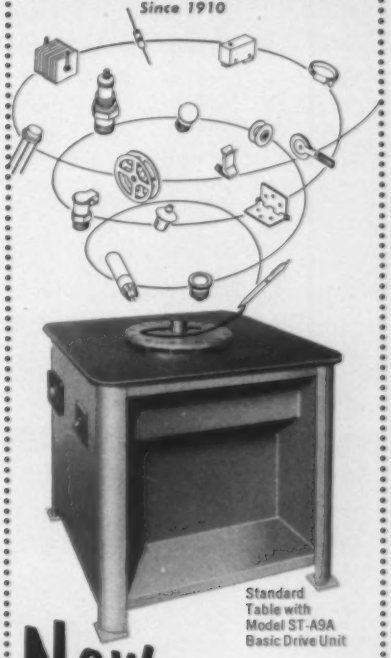
Belt Weigher

Item 419

Unit is designed to meet the needs of continuous process industries for measurement and control of flow of dry materials at low to medium rates from zero to 3000 lb per minute. Weigher operates over a 10 to 1 range, can be converted to 50 to 1 by a variable speed belt drive. Accuracy is within $\pm\frac{1}{2}$ per cent of the maximum rate. Positive chain drive eliminates slippage, and integrator totalizes correctly regardless of belt speed. **Omega Machine**

STANDARD TOOL AUTOMATION

Since 1910



Standard Table with Model ST-A9A Basic Drive Unit

New-

STANDARD TOOL

MODEL ST-A9A

Cam-Operated Indexing Unit

1. Higher Torque Rating
2. Greater Versatility
3. Can be furnished with dial plates, tooling plates and tables with standard and special drives

Automatic Machine Design and Construction Time can be Reduced as much as 50%!

Send for illustrated literature describing Standard Tool Indexing Units—the basic units for Automation

Basic Cam Operated Indexing Unit MODEL ST-A9A

STANDARD TOOL AND MANUFACTURING CO.

Creative Machine Designers and Builders

245 LAUREL AVENUE

KEARNY, NEW JERSEY

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Co., Div. BIF Industries Inc., 345 Harris Ave., Providence, R. I.

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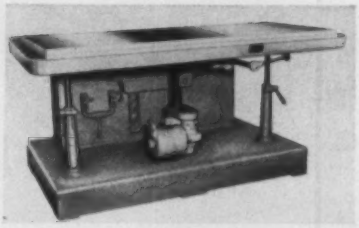
Elevating Worktable

Item 420

Power-elevated table is designed as an accessory for drilling machines. For loading heavy parts, the table can be moved to its lowest level, then raised to working position. One lever controls three actions. The first lever position lowers the table, the second raises the table, and the third locks the table in place. Limit switches control both top and bottom limits of table travel, and a gearmotor mounted to the table-elevating standard powers the unit. **Edlund Machinery Co.**, 112 Huntington St., Cortland, N. Y.



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Now! THE ALL-NEW DPS MODEL U (Universal) POWER SCREWDRIVER

WITH BRAND NEW FEATURES AND ADVANTAGES NEVER BEFORE AVAILABLE

NEW TYPE POSITIVE CONTROL CLUTCH

- Not affected by changes in temperature or excessive oil or grease
- Sharply increased accuracy as to variation in torque tolerance
- Simplified design for easy servicing
- Requires no daily lubrication
- No friction devices of any kind used
- Long service life on all parts subject to wear

NEW TYPE HOPPER DRIVING MECHANISM

- No gears to wear out
- No lubrication required
- No costly replacement parts
- Simple design for easy servicing
- Built-in slip control as a safety feature

Also furnished as a completely *Self-Contained Driving Head* for use in specially designed assembly machines.

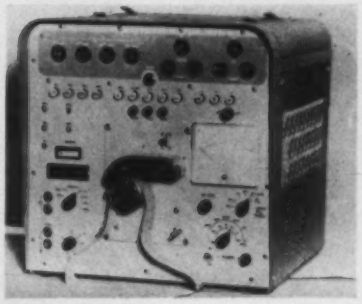
NEW TYPE FEED TRACK AND ESCAPEMENT MECHANISM

- Flexibility for easy and fast adjustment
- Escapement does not require daily lubrication
- Escapement design permits releasing screws by body or head as required
- Positive solenoid action
- Simple design for easy servicing
- Adjustable for full capacity of machine

Write for NEW Brochure!

DETROIT POWER SCREWDRIVER CO.

2811 W. FORT ST. DETROIT 16, MICH.



Programmed Tester

Item 421

Applicable in computers and electronic instruments, automatic tape programmed measuring instrument can be used for measurement of resistance, polarized dc or ac voltage, or insulation resistance. Model LA-302 provides a complete test record. It is adaptable to automated production, running 60-100 tests per minute. It can signal wiring or assembly errors with a flashing light indicator. The range of voltage measurement is 0.5 to 500 v. Resistance range of the unit is from 1 ohm to 9.99 megohms. **Lavoie Laboratories Inc.**, Matawan-Freehold Rd., Morganville, N. J.

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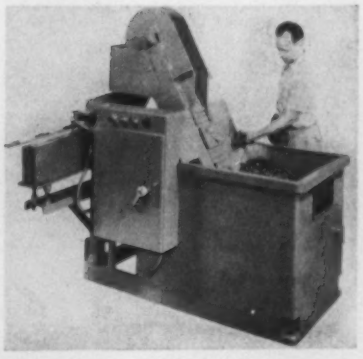


Storage Feeder

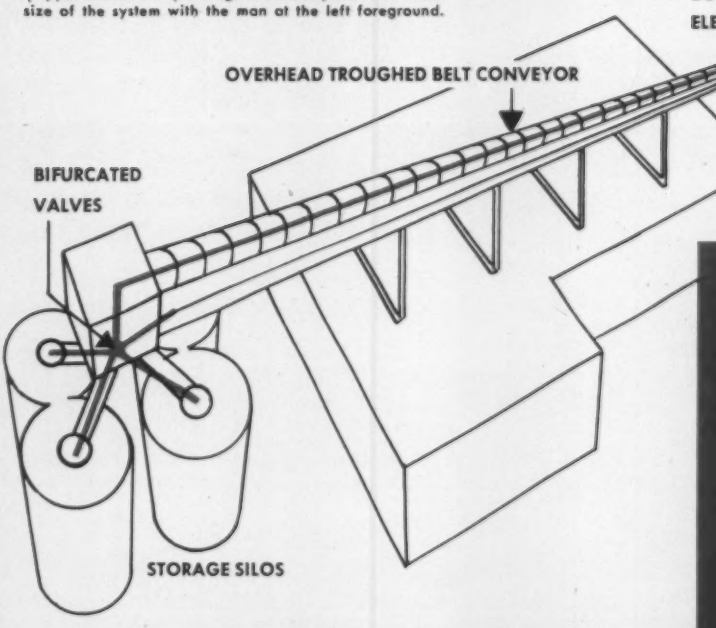
Item 422

Unit can orient and feed irregular stamped, machined, and cast parts. Production rate is up to 300 pieces per minute. The device delivers parts under power to the machine being fed. Parts that have

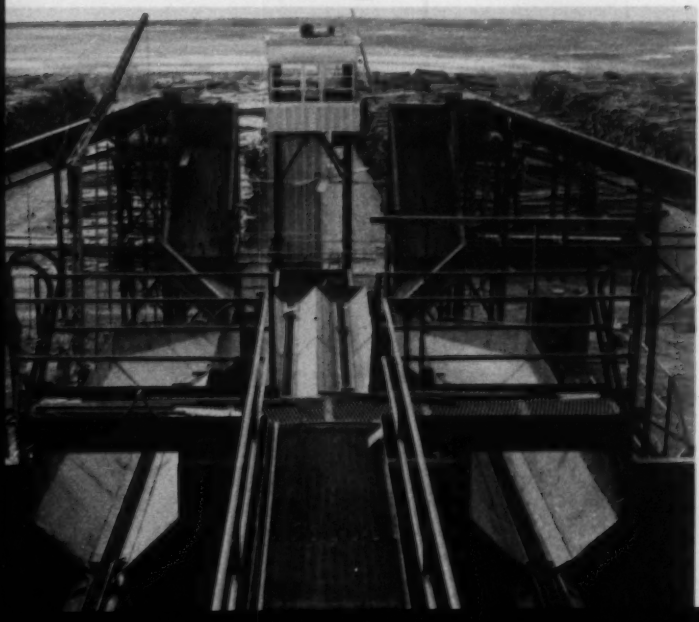
Circle 680 on Page 127

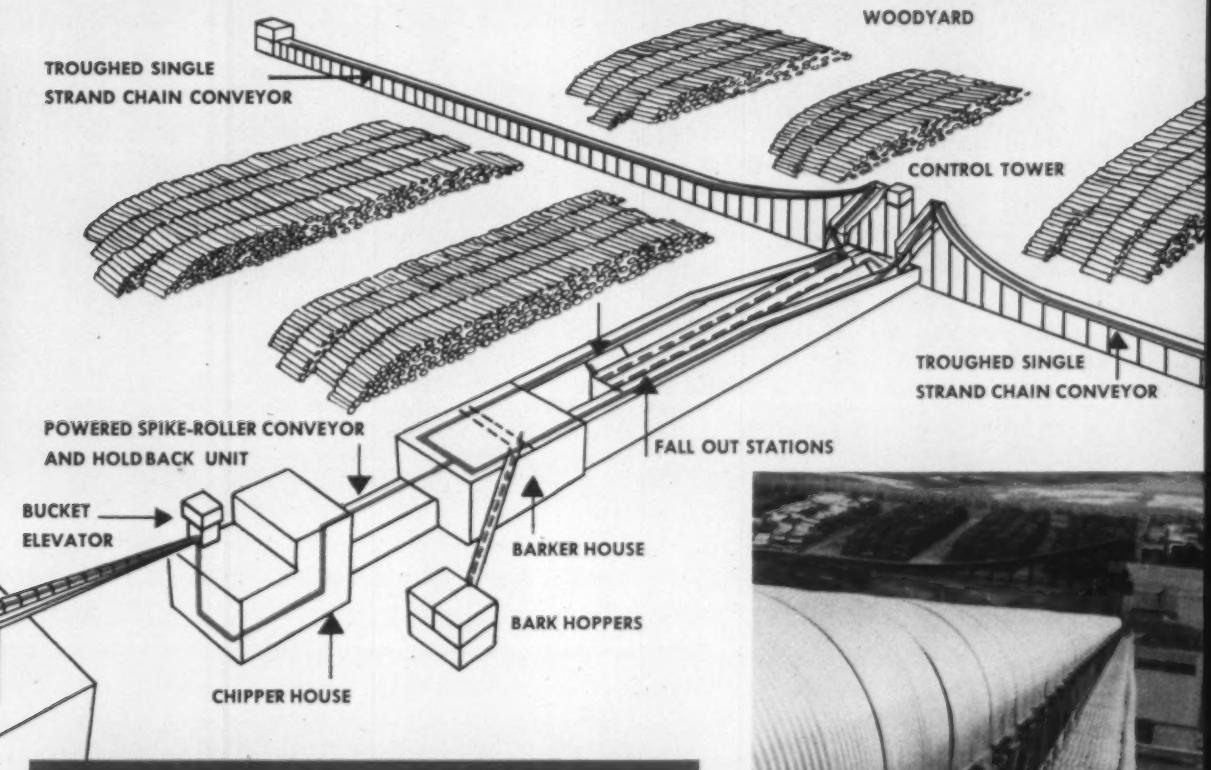
Circle 681 on Page 127→

The covered belt conveyor extends 343 feet from the chipper house to chip storage silos. Compare tremendous size of the system with the man at the left foreground.



The unique fall out stations, lower left and right, prevent jamming by dropping excess logs off the main-line conveyor to be recirculated later.





Only 5 Operators Required for 1,300 Foot Planet Bulk Handling System

This log handling, barking, chipping and storage system was built and installed by Planet Corporation at a new multi-million dollar hardboard mill constructed on the shores of Lake Huron by Stone & Webster for Abitibi Corporation. The system, which has eliminated jamming through a unique fall out station, makes it possible for 50 cords of logs per hour to be chipped and stored—ready for pulp processing. The entire system covers a distance of over 1,300 feet and is operated by only five men.

1. Actually, the system, from the woodyard to barkers, is double. It starts conveying from opposite ends of the woodyard with two troughed single strand chain conveyors. These two conveyors carry the eight foot logs from the woodyard through the log wash, fall out stations, inspection stations and barking operation.

2. A unique feature of the system is the fall out stations which prevent jamming by automatically arranging the logs approaching the barkers into single file. This is accomplished by dropping excess logs off the main-line conveyors onto recirculating conveyors. These feed the dropped logs back into the system assuring an uninterrupted flow to the barkers.

3. After the logs have been debarked, they emerge from the dual lines onto a powered spike-roller conveyor to be carried to the chipper. This conveyor has a holdback unit that prevents jamming in the chipper feed spout. The holdback unit, which raises from between the rollers, is manually operated by an air cylinder.

4. Following chipping, the chips are collected under the chipper on a belt conveyor. This conveyor transports them to a bucket elevator which lifts the chips to the roof of the chipper building. From here a long, covered troughed belt conveyor carries them to the storage silos.

5. The chips can be fed to any one of the four storage silos by means of bifurcated valves. From the storage silos, the chips are fed by rotary plate feeders at a rate of 2,500 cubic feet per hour onto a system consisting of six belt conveyors for delivery to the pulp processing operation.

View of the system from top of the chip storage silos looking down the side of the covered belt conveyor toward the woodyard. Lake Huron is in the background.

IT PAYS TO PLAN WITH PLANET

Here's an example of how Planet's engineering skill and know-how was put to use by one company. No matter what you make, it will pay you to have Planet Corporation on your team when you have a materials handling or automation problem to solve.

Planet Corporation is completely staffed with qualified and experienced graduate engineers. They will give your problem painstaking attention from preliminary surveys, engineering and design to installation and field testing.

Write or phone today to have a Planet sales engineer discuss with you the solution to your problem. There's no obligation, of course.

PLANET
CORPORATION
• ENGINEERED HANDLING SYSTEMS
• AUTOMATION EQUIPMENT
• FOUNDRY HANDLING EQUIPMENT
1810 SUNSET AVENUE LANSING, MICHIGAN

TO SOLVE ABITIBI'S BULK HANDLING PROBLEM, PLANET ENGINEERS OUTDID PAUL BUNYAN

...gigantic system delivers 50 cords of pulpwood per hour

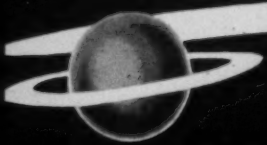
Abitibi Corporation wanted a log conveying system. It had to deliver 50 cords of pulpwood per hour from woodyard through barkers, and chipper to chip storage silos . . . and the old bugaboo of jamming had to be eliminated!

Planet engineers combined systematic, logical procedure with creative engineering to bring Paul Bunyan . . . and his blue ox Babe . . . back to northern Michigan in the form of a gigantic bulk handling system. For the interesting details of the "Paul Bunyan" that was developed, look to the left and under this flap.

The Planet staff is well qualified to solve your materials (either bulk or unit) handling or automation problems. Its experience and know-how has been gained in creating complex engineered systems for many of the country's largest companies.

It paid Abitibi to "Plan With Planet" . . . it will pay your company too. Write or phone today.

PLANET CORPORATION



- ENGINEERED HANDLING SYSTEMS
- AUTOMATION EQUIPMENT
- FOUNDRY HANDLING EQUIPMENT

1810 SUNSET AVENUE LANSING, MICHIGAN

been turned, threaded, drilled, milled, and slotted in previous operations may be handled. Parts having soft machined surfaces, including threads, can be fed without harm. A variable speed drive, located in the hopper base, has a foot-mounted motor and an overload clutch. The orientor propels the parts by a natural frequency conveying method. Model shown is a 5 cubic foot unit, is tooled to feed turned parts to a centerless grinder. The feeder is also available in 10 and 20 cubic foot storage capacities. **Campbell Machines Co.**, 18634 Fitzpatrick, Detroit 28, Mich.

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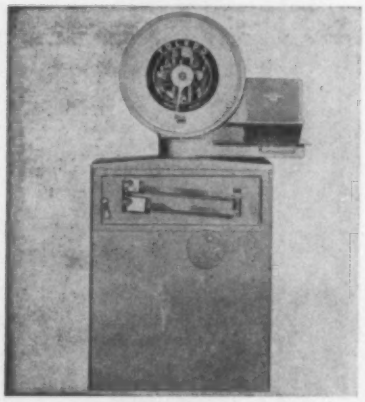


Weight Printer

Item 423

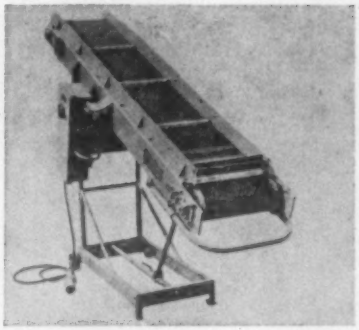
Unit can record at the scale, or at a remote position. Information such as full weight, time, and date can be printed on office forms or tickets. This data can be transmitted in digital form to remotely located office machines such as adding machines and tabulator tape punches. When using unit weights to increase dial capacity, they can be identified by selective numbers which are available in keyboards with from six to as many as twelve banks. Scale can also be equipped with a second dial for back indication. **Toledo Scale Div., Toledo Scale Corp.**, Toledo 13, Ohio.

Circle 423 on Page 127

Portable Conveyor

Item 424

Capable of conveying heavy metal stampings between presses, portable conveyor unit is also suitable for



the mechanized handling of all types of heavy parts and assemblies. Conveyor pitch can be adjusted for any angle up to 45 degrees from the horizontal. A locking device permits up-and-down adjustment to working height. Conveyor is available in various widths and lengths with belts of Neoprene-impregnated cotton, metal or cotton-cleated belting, or wire mesh. **May-Fran Engineering Inc.**, 1761 Clarkstone Rd., Cleveland 12, Ohio.

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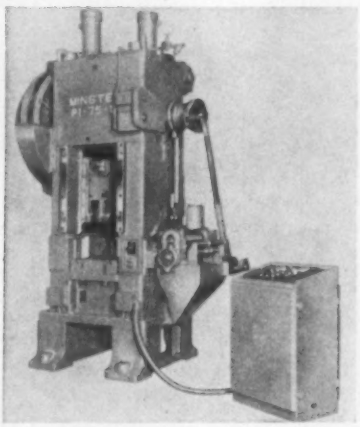


Single Point Press

Item 425

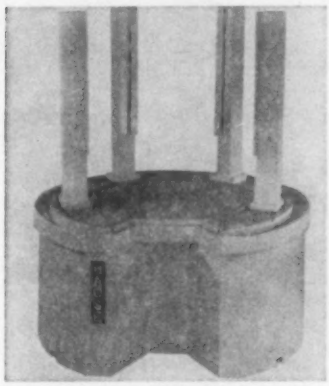
Designed for progressive die blanking and perforating operations which involve heavy stock loads, single point press is available in 75, 100, and 150 ton capacity. A combination air friction clutch and brake provides fast action at any speed, and has quick, controlled stopping. The design of the single point box-type slide assures precise slide-to-bed parallelism. Recirculating lubrication system provides a constant, controlled flow of oil to all bearing surfaces. **Minster Machine Co.**, Minster, Ohio.

Circle 425 on Page 127

Radial Machine Base

Item 426

Base is designed for machines that perform drilling and tapping operations. A number of units can be mounted horizontally around the base center and vertical columns can be incorporated to mount units overhead at 90 degrees. Two circular tee slots provide location adjustment and clamping strips provide lateral adjustment. Top of



Model M60C is 64 inches in diameter, has a 56-inch diameter working surface. An outer rim area for chip collection is tapered to a screened outlet for coolant drainage. A rear opening is provided for internal mounting of a removable-type coolant pump reservoir system. **Hause Machines Inc.**, 809 S. Pleasant St., Montpelier, Ohio.

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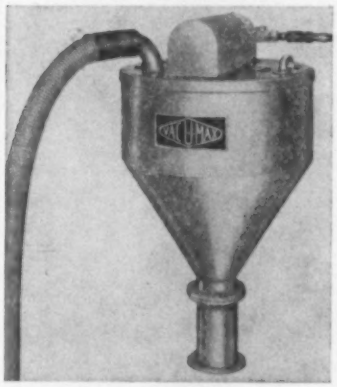


Vacuum Hopper Feeder

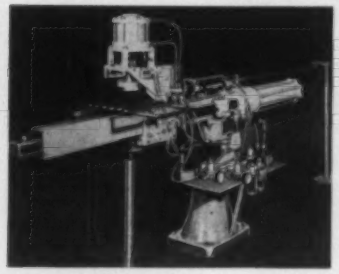
Item 427

Device is capable of transferring either wet or dry materials from bulk bins or shipping containers into processing machinery such as mixers, blenders, and mills. To transfer the material, an adapter or

shaped cover is fitted over the charge port of the equipment and the unit feeds directly into the machine.

Feeder operates on compressed air, is suitable for use in hazardous locations. Discharge valve closes automatically when the unit is drawing material into the hopper. When the hopper is full, the air is shut off and the material is held in the hopper until needed. For fine, dusty material, the unit can be equipped with an internal filter, and rotary type air lock discharge valves can be used. **Vac-U-Max,** 1 Montgomery St., Belleville 9, N. J.

Circle 427 on Page 127



Tube Bender

Item 428

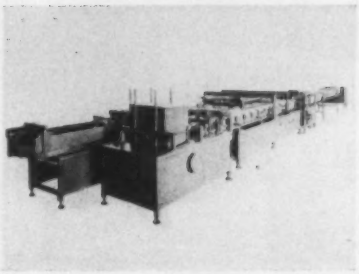
Air-operated machine can produce multiple, wrinkle-free bends up to 180 degrees in thin-wall (0.017-inch) copper and aluminum tubing. Large multiturn coils in a variety of shapes can be produced from tubing ¼ to ⅝-inch in diameter and up to 40 feet in length. Speeds up to 900 bends per hour are possible. Model S includes an automatic head, feed, and table return. A quick-change bending angle selector facilitates setup. **Paul Machine Tool Div., Paul Machine Tool & Die Works,** 4600 S. Kedzie Ave., Chicago 32, Ill.

Circle 428 on Page 127

Bulk Packaging Machine

Item 429

Automatic high-speed bulk packaging machine is capable of handling gallon-size cans of antifreeze, or twelve ounce cans for a brewery. With the twelve ounce cans, packaging rate is over 700 per minute. In operation, the magazine is filled with knocked-down containers. The



machine automatically feeds knocked-down corrugated shipped containers into a mechanical case-forming mechanism from which cases are positioned, end-loaded, sealed, and discharged.

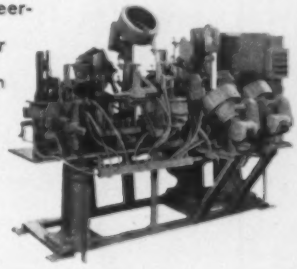
The cans travel upright in a smooth continuous motion; are protected from damage such as denting and defacing of labels or lithographed surfaces. The end-opening cases provide protection in shipping and storage, also allow convenient stacking arrangements. **J. L. Ferguson Co.,** Joliet, Ill.

Circle 429 on Page 127

Part: Carburetor economizer diaphragm valve.
Operation: Gaskets and diaphragm cut from reel stock. Seven parts assembled.
Production: 900 valves per hour.

83% labor savings with automated assembly!

Can you automate your assembly operation economically? Gray's engineering staff is best equipped to answer your question. Design, manufacture, installation and initial operation of automated assembly equipment is our only business.



Write for our 24 page bulletin, "Automated Assembly."

gem **GRAY equipment company**
13600 Ford Road • Dearborn, Mich. • Telephone: Tiffany 6-7373

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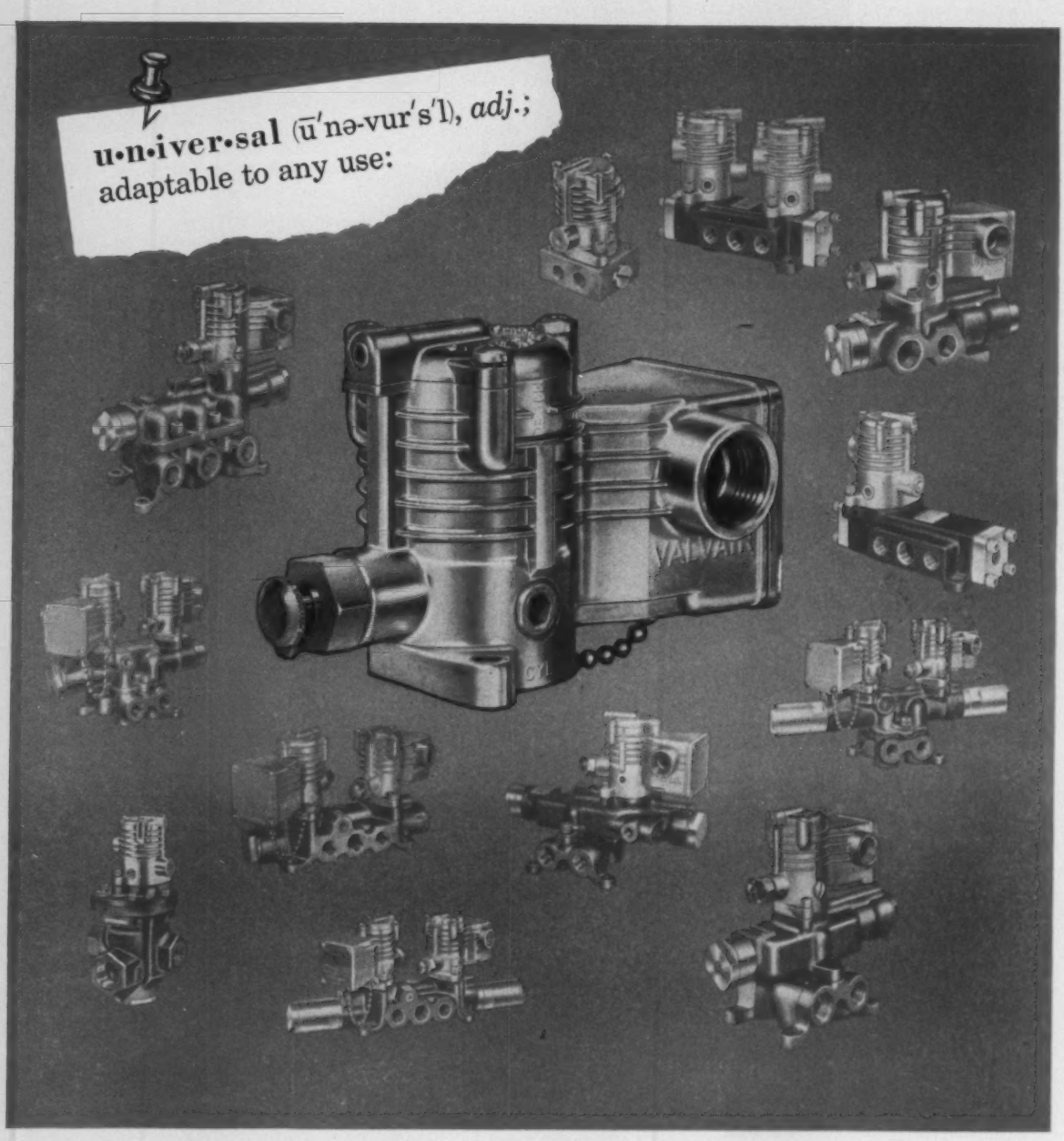

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Valvair's one *universal* pilot—completely interchangeable on all Speed King valves—has only two moving parts. It's built to handle your toughest jobs.

Why complicate production, maintenance and parts inventory on the machines you build or operate, by using control valves that require an assortment of pilots?

For peak performance . . . unmatched reliability . . . minimum parts inventory . . . specify Valvair Speed Kings, the valves with *universal* pilots! Valvair Corporation, 454 Morgan Avenue, Akron 11, Ohio.

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Representatives in principal cities

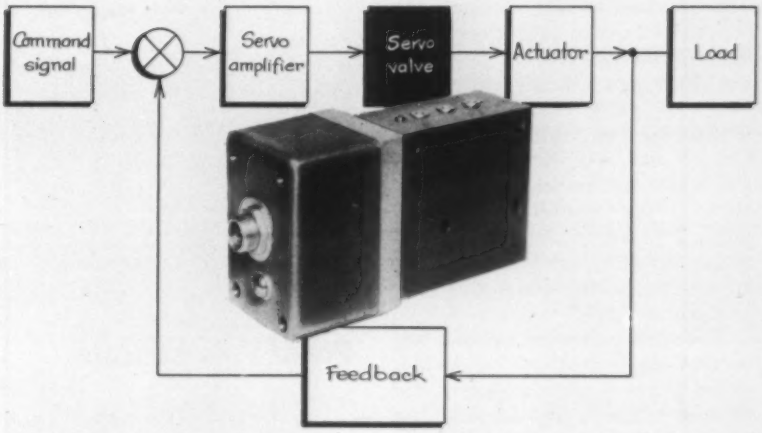
Circle 683 on Page 127

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 127.

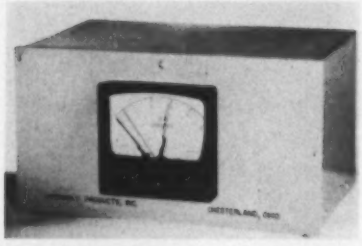
Hydraulic Servo Valve



SERVO valve is designed by **Vickers Inc.**, 1400 Oakman Blvd., Detroit 32, Mich. for industrial and ground ordnance applications such as machine tools, processing lines, and variable speed drives. It provides accurate flow modulation required for the closed loop, program-controlled combinations of position, velocity, and acceleration. The two-stage valve has four moving parts: Main spool, control spool, sleeve, and feedback linkage. The mechanical feedback linkage with variable fulcrum makes the valve flexible and compatible with various conditions of flow, response, and pressure. Valve is agreeable to various methods of programming command signals—from a calibrated potentiometer to punched or magnetic tape reader systems.

Rated at 10 gpm maximum flow at 1000 psi, device operates on supply pressure up to 3000 psi. By means of the mechanical feedback linkage, the valve can be trimmed to handle 10 gpm with as little as 300 psi supply pressure. It can be gasket or subplate mounted to a hydraulic motor.

Circle 430 on Page 127



Rate of Change Control

Item 431

Unit automatically controls the rate of change of current to a device such as a motor. Basic element in the unit is a differential contact meter-relay that has two moving coils. Polarity of the coils is such that the single indicating pointer shows the sum of the signals passing through the two coils. A bias voltage is being produced internally in the control and it is impressed on the bias winding of the differential meter-relay. The bias signal is impressed across a 25 ohm potentiometer which is mechanically linked to a timer motor and reset mechanism.

The low adjustable contact on the meter-relay has been preset to the original amount of the bias signal, so the reduction of the bias signal by the timer motor results in meeting and locking of contacts on the indicating pointer and the low adjustable pointer. When the relay, which is connected to the pointer contact, is actuated, it produces a pulsing signal. The pulsing signal is impressed on a fractional horsepower ac motor which is connected to a Variac. Output of the Variac controls the device, and a current from the device feeds back as the input signal. At the end of the preset timing run, the timer switch closes and the fractional horsepower motor is put into high speed. Output of the Variac is then increased rapidly to the high limit on the meter-relay. When the high contacts close, the relay operates and the timer is reset. The next cycle begins with momentary closure of the trigger contacts. **Assembly Products Inc.**, 75 Wilson Mills Rd., Chesterland, Ohio.

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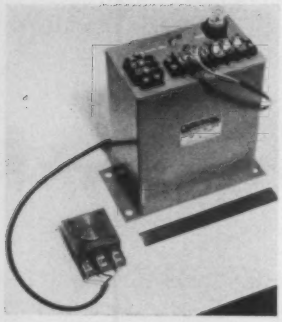

Proximity Limit Switch

Item 432

Constructed without moving parts or contacts, device has an operating life which is independent of switching operations. Limit switch includes two parts. The encapsulated sensing element contains an open *C* core and two windings as elements of a variable reluctance bridge circuit. The control element contains a balance circuit, amplifier, phase detector, precision flip-flop circuit, transistor output amplifier, and power supply.

The sensing element is positioning so that the ferrous part to be detected passes across the face of the element within a trip distance that is adjustable between $\frac{1}{8}$ and $\frac{1}{2}$-inch. When magnetic material enters the critical zone selected, it causes the sensing bridge circuit to be unbalanced. The signal resulting is then passed to the control element where it is converted into a digital 24 volt output for driving subsequent control devices. **Westinghouse Electric Corp.**, P. O. Box 2099, Pittsburgh 22, Pa.

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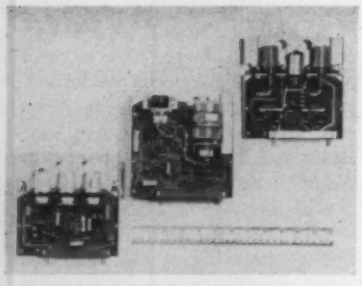

Printed Circuit Bales

Item 433

Line of plug-in printed circuits is suitable for computer and control applications. A feature of the bales is that each component can readily be replaced. Other features include printed wiring, conservatively rated components, plated-through and eyeletted holes, tube heat sinks, right-angle connectors, and rigid board mounting frames.

Some of the bales available are: multivibrators, high speed binary and decimal electronic counters, stepping switches, operational amplifiers, timing and delay circuits, relay and switching circuits, voltage regulators, and pulse generators. **Skiatron Electronics & Television Corp.**, Dept. AC, 180 Varick St., New York 14, N. Y.

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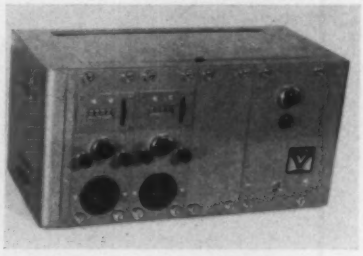

Paper Void Indicator

Item 434

Developed for the paper industry, instrument checks every inch of paper, automatically finds holes, measures them, pinpoints their position on a giant sheet, counts them, records them, and signals the operator. Unit includes a feeler brush which is electrically linked to the indicator unit. In operation, the product (machine is also suitable for material such as rubber or plastic) is passed between the feeler brush and a metal roll, plate, or bar. Whenever a hole appears in the material under inspection, the metal brushes contact the grounded roll, and immediately transmit a low voltage pulse to the indicator unit.

Each unit is equipped with test and reset switches for checking the system before or during operation. Optional accessory equipment includes audible or visual signals, an automatic web marker which will locate and mark defective areas, and a 24-hour chart recorder which provides a continuous record of inspection findings and equipment usage. **Viking Instrument Inc.**, East Haddam, Conn.

Circle 434 on Page 127

Electronic Counter

Item 435

Unit is designed to count accurately at speeds up to 30,000 counts per minute for more than one billion counts. It can be used to measure accurate lengths, to count high-speed shaft revolutions, and to count objects like bearings, packages, cans, etc. Model N-1 includes a glow-transfer, cold cathode counting tube, a high-speed magnetic counter, and a small photohead. The photohead can be assembled in configurations to meet the requirements of any application. The use of transistors and printed circuits allows low heat and simple wiring. **Veeder-Root Inc.**, Hartford, Conn.

Circle 435 on Page 127

Lathe Tracer Attachment

Item 436

Tracing applications such as step shaft turning, contour turning, and facing operations involving complex contours can be performed by an unskilled operator with lathe tracer attachment. Attachment is adaptable to almost any make of lathe, but does not alter it so that normal turning cannot be performed. Flat or round templates can be used. Centers are provided for mounting the round templates; hold-down clamps mount flat templates. With the template rail mounted to the

rear of the lathe, the operator has visual access to the template. Accuracy between the tracer stylus, the template, and the workpiece is maintained by micrometer adjustment screws in both the lateral and longitudinal positions. This feature provides the operator with positive control of the tracer for rough to finish turning. **True-Trace Sales Corp.**, 9830 E. Rush St., El Monte 50, Calif.

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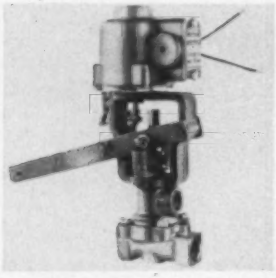

3-Way Solenoid Valve

Item 437

Reset valve can handle air, gas, oil, or water at temperatures to 212 F. Unit is applicable wherever a valve is required that can be manually set and held in one position and returned to its original position electrically. Two types of operation can be supplied; no voltage release or electrically tripped. A soft composition disc provides tight seating on all mediums. Valve is available in ½, ¾, or 1-inch npt, ac or dc voltage. **Automatic Switch Co.**, Florham Park, N. J.

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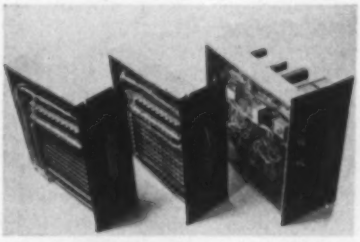

Crossbar Scanner

Item 438

Instrument is capable of scanning 500 pairs of input connections at a rate of 50 pairs per second, is suitable for scanning thermocouple voltages, strain gage voltages, and analog computer outputs. Model SC 2 is designed around a crossbar switch and operates from a beam-switching commutator which is buffered with transistors.

Normal operating speed is 50 pulses per second, with a minimum dwell time of 5 milliseconds at each selected pair of points. Higher and lower repetition rates are possible. Unit will step with positive pulses of at least 25 v amplitude and a rise time between 0.02 and 1 microsecond. An indication contact is also provided which closes after the last point has been scanned, and can be used to actuate external equipment to interrupt the flow of stepping pulses to the scanner. When this contact closes, the scanner returns to a *Start* position exclusive of the 500 pairs of scanned points. **James Cunningham Son & Co. Inc.**, P. O. Box 516, Rochester 8, N. Y.

Circle 438 on Page 127

Pneumatic Relay

Item 439

Device is applicable for pressure-temperature compensation or remote adjustment of proportional band in single or multielement pneumatic control systems. Relay combines two or more pneumatic signals in varying, predetermined proportions. It multiplies or divides one pneumatic signal representing a measured variable by some predetermined function of a second variable. Unit also adds and subtracts pneumatic signals and provides proportional control action.

The pneumatic relay has a bellows operator which positions the proportional band adjustment in the relay. This bellows can be actuated by a pneumatic signal from a remote adjuster or from a pneumatic transmitter. Unit uses ranges of 3-15 psig and 3-27 psig. **Bailey Meter Co.**, 1050 Ivanhoe Rd., Cleveland 10, Ohio.

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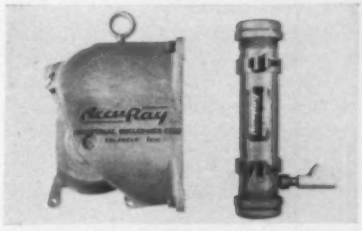


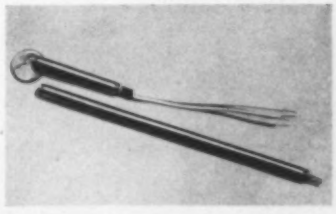
Detector-Controller

Item 440

Tank level detector-controller has a two-fold function. It can be installed so as to provide a relay closure signal when the level rises above or falls below the level of the detector, or it can be installed so that both a high level and a low level signal can be provided from one instrument. Accuracies to plus or minus 1/16 inch are available. Unit is set up outside the tank; no part of the instrument extends into the tank or vessel. This feature allows the instrument to be fail safe for either the high level or low level signal.

Opposite the detector or across the chord of the tank, a suitable source of radiation can be installed. This source housing provides adequate shielding to reduce the external radiation field below acceptable tolerance. The radiation field required for operation is 0.2 mr/hr. **Industrial Nucleonics Corp.**, 1205 Chesapeake Ave., Columbus 12, Ohio.

Circle 440 on Page 127



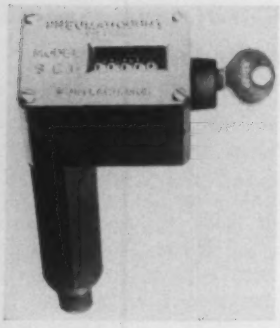
Cartridge Heating Unit

Item 441

Device is constructed to provide localized heat to restricted areas requiring close thermal control, such as dies, platens, and processing

equipment. Maximum surface temperature is up to 1250 F. Heating cartridge has a stainless-steel sheath, rigid external terminals with repairable nickel alloy leads, and moisture resistant units. Unit is available in any length from 1 inch. Wattage ratings are supplied on the basis of 50 w per square unit of surface, with higher ratings for special applications. **Hotwatt Inc.**, 16 Gould St., Danvers, Mass.

Circle 441 on Page 127

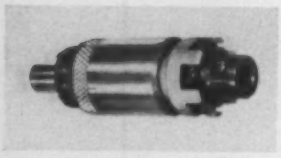


Hydraulic Counter

Item 442

Five-digit counter registers up to 300 counts per minute, is suitable for any operation controlled by hydraulic action. There is no overtravel to damage counter and no undertravel for half or miscounts. To install, the unit is merely screwed into the line controlling the hydraulic cylinder. When used with variable stroke cylinders, the counter does not have to be adjusted when changing the work stroke. Unit is available in knob or key reset, for use at 50 to 8000 psi. **Pneumaticount**, 3400 N. E. 54th Ave., Portland, Ore.

Circle 442 on Page 127



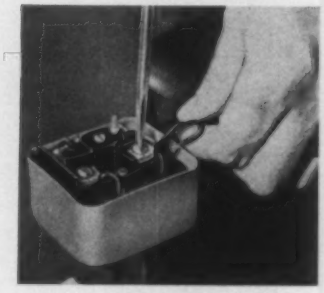
Overload Clutch

Item 443

Device is applicable wherever torque control and protection is required, such as on instruments, machine tools, hand power tools, and in packaging lines. Typical uses include fastening screws or tightening bolts, feeding easily torn wrapping materials in packaging lines, take-up spools for paper, and tensioning bandsaw blades.

Two types of clutches are available; the one-shot type and the continuous overriding type. One-shot clutch can be re-engaged in various ways, depending on the particular design—by reversing the rotation of the drive shaft; by axial movement; or by other means determined from the specific application. Continuous overriding clutch can be used on slow-running applications like hand-tightening of fasteners. Built-in protection allows the equipment to be operated at rated power with the clutch providing the necessary protection. Torque ratings furnished are from zero to 84 lb-in. and 48 to 120 lb-in. **Scully-Jones & Co.**, 1901 S. Rockwell St., Chicago 8, Ill.

Circle 443 on Page 127



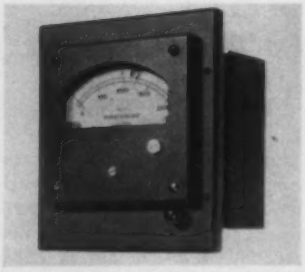
Pressure Switch

Item 444

Unit is applicable as a control for low pressure air compressors, paint sprayers or any system requiring automatic control of pressure between preset limits. The pressure switch has 85 lb maximum capacity, is rated through one hp, 110-220 v single phase. The wiring terminals are accessible from the top, and to install, the wire is inserted under the connector and tightened with a screwdriver.

Pressure settings are set at the factory for individual specifications, but an adjustment screw is provided to permit the setting to conform with the application. A lever bearing in the switch mechanism assures no-drift settings. **Furnas Electric Co.**, 1128 McKee St., Batavia, Ill.

Circle 444 on Page 127

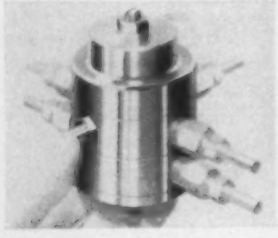


Temperature Controller

Item 445

Instrument can be applied wherever a thermocouple can be used to measure temperature. Unit uses one single-purpose tube and only a few small-size components. A steel case gives the meter immunity to stray magnetic fields. A visible pilot light on the front of the case signals *On* when the controller is calling for heat. Where special control problems require two target settings, the unit can be furnished with two adjustable targets. A temperature change of 0.3 per cent of full scale will cause control action. Scale spans from 400 F to 3000 F are available. Contacts are rated 10 amp, 115 or 230 v ac. **Illinois Testing Laboratories Inc.**, 420 N. LaSalle St., Chicago 10, Ill.

Circle 445 on Page 127



Pneumatic Monitor

Item 446

Control device is a monitor instrument designed to trip when a pneumatic signal violates its minimum or maximum setting. It remains tripped after the signal is restored to normal limits until manually reset, either locally or remotely. Trip point is adjustable from 1 to 100 psig. Repeatability is ± 0.25 psi. When in service, the unit, which is designated Mite-73, will relay the input signal to either the lock-up or vent port. **George W. Dahl Co. Inc.**, 86 Tupelo St., Bristol, R. I.

Circle 446 on Page 127

Circle 684 on Page 127→

How to write 10,000-cycle data on a pen recorder

A tape tie-in banishes frequency-response limitations and saves paper

We will cancel the laws of physics, throw out inertia, and behold here is a pen recorder writing out 10,000 cycles per second ready to read. Don't scoff. There is a way. Assuming visual data is really what you want, keep your eye on the oscillograph or pen recorder, and think of the tape recorder as an ingenious "frequency-response extender" or "data stretcher."

A SLOW-MOTION LOOK AT TRANSIENTS

When an aircraft manufacturer was having shock problems from the firing of an experimental plane's armament, nothing could be seen in real-time data. For a better look, shock waves were recorded on tape, slowed down, recopied and then written out in visual traces. A thousandth of a second was stretched out to a full second. The exact extent and nature of the shock pattern and its manner of transmittal through the plane's structure became clearly evident – and with it the design solution.

100-TO-1 DATA STRETCHOUT (and more)

Compared to any visual-trace recorder, an Ampex instrumentation tape recorder has virtually unlimited response. Frequency components as high as 10,000 cycles per second (and much more) are easily recorded. And tape has decided advantages too at 1000 or 2000 cycles. A tape speed of 60 inches per second captures any of these higher frequencies and has tremendous room for slowdown on playback. Reproducing the tape at 0.6 in/sec. reduces 10,000 cps. to a mere 100. Connect a direct-writing recorder to the tape recorder and 100 cycles response is all that you need.

Actually Ampex has a wide range of tape speeds and tape slowdown ratios available. Tapes can be recopied once or even twice multiplying these ratios accordingly.

TYPICAL TAPE SLOWDOWN (OR SPEEDUP) RATIOS			
AMPEX MODEL	Basic speed ratio	First recopy	Second recopy
FR-1100	8 to 1	64 to 1	512 to 1
FR-100	32 to 1	1024 to 1	32,768 to 1
FR-1100 multirange (many versions available)	100 to 1	10,000 to 1	1,000,000 to 1

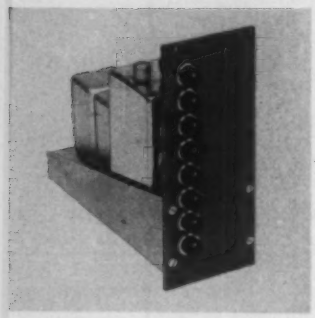
24 TIMES AS MUCH RECORDING TIME

On 5000-cycle data, an ordinary 10½" reel of 1-mil magnetic tape will record 24 minutes. On a visual-trace recorder writing 100 cycles per inch, a 250-foot magazine of expensive paper would last just one minute! When you record data first on tape, you will seldom recopy the whole test onto paper. With an oscilloscope or other scanning device, you find the important parts of the tape and copy as little as a few seconds onto the visual medium. The tape can be stored for future reference, cut into loops for analysis or can be erased and reused. It saves hundreds of feet of paper.

Because magnetic-tape data is an "electrical analog", it can also be used for automatic frequency analysis, computer input, simulation of phenomena and scanning, counting and correlating techniques. We have told the whole magnetic-tape story in a well illustrated and diagrammed 16-page brochure. For your copy, write Dept. ME-13.

AMPEX INSTRUMENTATION DIVISION • 934 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Phone your Ampex data specialist for personal attention to your recording needs. Offices serve U. S. A. and Canada. Engineering representatives cover the free world.



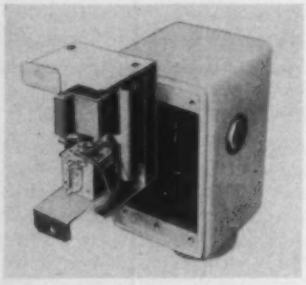
Alarm/Scanning System

Item 447

Device is capable of automatically gathering alarm and control data from remote stations in chemical and petroleum plants, can also be used to scan and telemeter quantities such as velocity, flow, temperature, pressure, and resistance. Unit then transmits this data to a central station over wire or radio for visual and aural presentation.

Scanner is electronic, uses transistors and diodes, has no moving parts. In operation, the unit scans all the alarm or data points in a network at a predetermined rate ranging from two-tenths of a second per step to a twenty-thousandth of a second per step. It picks up alarm conditions from a switch closure and transmits the information back to a supervisory station to alert workers. **Moore Associates Inc.**, 2628 Spring St., Redwood City, Calif.

Circle 447 on Page 127



Photorelay

Item 448

Construction of printed-circuit relay makes it adaptable for use on material-handling, packaging, and processing machinery, where there may be dust, vibration, humidity, high temperature, or severe voltage fluctuation. Relay is mounted on a single board, clamped in a stamped-metal cradle, and can be removed like a switch. The highly directional response to about 10 foot-candles of light makes it suitable for direct use on all types of conveyor machinery, and tow-line systems. Unit is rated for 100-130 v, 50/60 cycles. **Photobell Co. Inc.**, 43 Vesey St., New York 7, N. Y.

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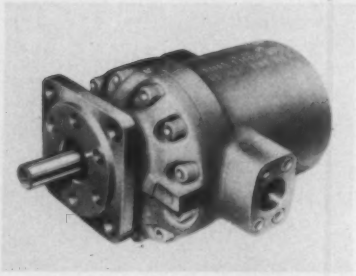

Hydraulic Pump/Motor

Item 449

Unit is adaptable for 2000-3000 psi industrial service. When used as a pump, it is suitable for continuous operating pressure of 2000 psi, with surge pressure to 3000 psi. Capacities are from 7.5 to 12 gpm at rated speed of 1200 rpm. When the unit is used as a motor, it provides maximum torque at stall and constant torque output with a flat characteristic curve from zero to maximum design rpm. The motor is instantly reversible, can carry overhung chain or belt loads. High torque at slow speeds permits direct connection without gear or belt reductions. Unit can be flange or foot-mounted. **Berry Hydraulics Div., Oliver Tyrone Corp.**, Oliver Bldg., Pittsburgh 22, Pa.

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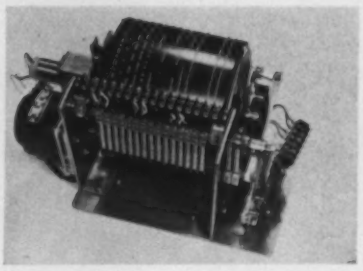
Drum Quantizer

Item 450

Electromechanical device converts electric input signals directly to various forms of output codes. When used with other components, it is capable of providing digital outputs for almost all transducers and other electrical signal sources. As many as 20 drum positions can be read out in the form of three characters of Teletype code or six-teen binary bits.



The drum can store up to 3200 binary bits of information in any desired code. Electrical contact springs are arranged to strike along a row of pins when drum read-out is needed. Alignment of contacts is provided by a knife-like member inserted between teeth of a quantizing gear. An electrical signal is injected into the servo system to assure read-out in the correct drum position. The angular drum position is directly related to the magnitude of input signal. The input can range in magnitude from about 1 mv full scale to several volts, and accommodate special conditions such as a suppressed zero scale, ground isolation, or use of an external reference. **Western Apparatus Co.**, 2001 Greenleaf St., Evanston, Ill.

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Magnetic Disc Brake

Item 451

Model DM is a direct acting magnetic disc brake that is spring-set and magnetically released, is designed for use with electric motors. Positive spring action is exerted on the pressure plates when the current is cut off and produces smooth, accurate stopping. The brake is released by energizing the magnet. This causes the pressure plates to part and allows the friction linings to float freely. The shaft of the motor or other ma-

chinery controlled by the brake is keyed directly to the operating elements of the brake. Torque ranges are from 30 lb-ft to 7500 lb-ft **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

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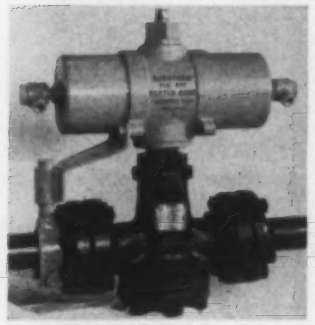

Fluid Operated Actuator

Item 452

Unit is adaptable to plug valve stems, can be placed over the valve while it is in operation. Features of the actuator include a totally enclosed piston, rack, and gear assembly fully submerged in an oil bath. When it is necessary to have a valve close or open upon loss of operating pressure, a kit is available for adapting the actuator without dismantling it or removing it from the valve. Actuator is available with torque output from 3000 lb-in. to 25,000 lb-in. with 100 psi operating pressure. Other units can be furnished for high torques, gear head valves, direct operation off high line pressures, and electrohydraulically operated devices. **Bettis Corp.**, Houston, Tex.

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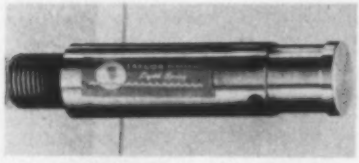
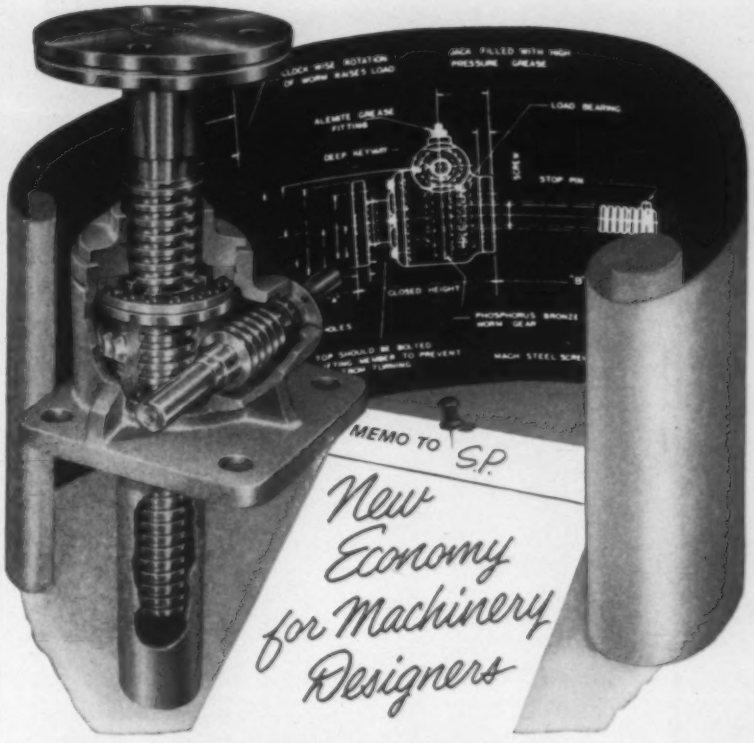


Liquid Spring

Item 453

Device features a time delayed return using liquid compressibility. By absorbing 98 per cent of the input energy, the unit returns the damped device in from 1 second to 30 minutes. The device is available



NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-GG, which includes drawings and full specifications.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet, Screw,
Hydraulic, Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever
Spur Gear, Electric

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in sizes up to 44,000 inch pounds of energy absorption with up to 2-inch strokes. Absorption is adjustable up to 98 per cent of the input. Standard model can be modified to provide time delay return up to ½ hour on a ½-inch stroke. **Taylor Devices Inc.**, 188 Main St., North Tonawanda, N. Y.

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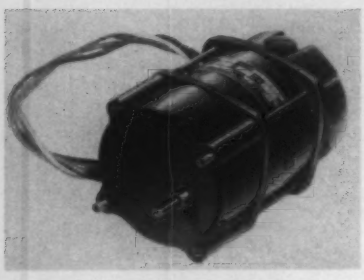

Sub-Fractional HP Motor

Item 454

Variable speed sub-fractional hp dc motor, Model RBD-25, is designed to be interchanged with company motor, Model RBC-25. Unit is furnished in two styles: 2505 is rated at 0.5 oz in., 115 v, 1800 rpm, 10 w; 2510 is rated at 1 oz in., 115 v, 1800 rpm, 15 w, or from 24 v to 115 v with speeds from 900 to 3600 rpm. The motors have gear reductions in ratios from 3 to 1 to 3600 to 1. **Holtzer-Cabot Motor Div., National Pneumatic Co. Inc.**, 125 Armory St., Boston 19, Mass.

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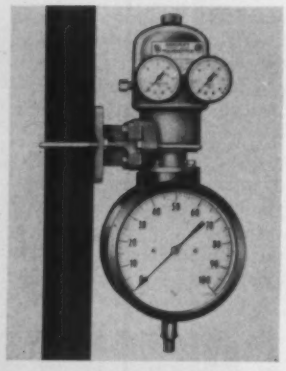

Pneumatic Transmitter

Item 455

Indicating pressure transmitter uses a Duragage as the sensing and indicating element for measuring pressures up to 100,000 psi with an accuracy of ½ of 1 per cent. Transmitter output is a 3 to 15 or 3 to 27 psi signal proportional to the input pressure. Transmitter element operates on the motion-balance principle. A rear disc is provided for access to both gage and transmitter, also serves as a safety blow-out relief.

Also available is a nonindicating pneumatic pressure transmitter which is suitable for feeding to indicating gages, recording receivers, or controllers. It has range of zero to 100 inches of water and zero to 20,000 psi, with an accuracy of ½ of 1 per cent and a sensitivity of 1/10 of 1 per cent. **Manning, Maxwell & Moore Inc.**, Stratford, Conn.

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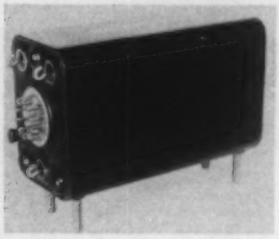

Selector Switch

Item 456

Suitable for automatic operations requiring high voltage, hermetically sealed rotary selector switch is rated at 1650 v dc, 20 ma. The sealed case protects the switch mechanism and contacts from moisture, dust, and tampering. Other performance characteristics of Model C-80335-001 are: 28 v dc normal operating voltage, 2.3 amp coil current at rated voltage, Hi-Pot rating of 2000 v dc with maximum leakage of 1 microampere, expected service life of 50,000 makes and breaks, and switching time of approximately 90 milliseconds. **G. H. Leland Inc.**, 123 Webster St., Dayton 2, Ohio.

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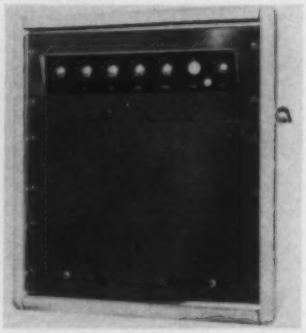
Linear Measuring Unit

Item 457

Instrument is applicable to machine tools or inspection equipment where linear displacement must be determined rapidly and accurately. Measuring system includes an optical unit, counter unit, optical gratings, and the grating mountings. The reference element for the system is an accurately ruled optical diffraction grating. Two equally ruled gratings are superimposed with one tilted slightly with respect to the other and light is shone through them. When one grating is moved with respect to the other in a direction at right angles to its line structure, the fringe pattern travels at right angles to the direction of movement. A relative travel of one grating line width causes a complete cycle of light and dark on the interference pattern to pass a given point where it can be detected by a photosensitive element. Current rulings of 500 and 2500 lines per inch give accuracies of 0.001 inch, 0.0005 inch, and 0.0001 inch.



The counter unit contains circuits to convert the phase and quadrature signals from the optical unit into a form suitable for operation of the reversible counter. The counter is capable of following the highest frequency signals which might be encountered. Positional information is displayed on five Dekatron Counter tubes plus a one inch CRT. A twelve position counter tube is used for checking errors in any of the five Dekatrons. **Electronics Div., Ferranti Electric Inc.**, 95 Madison Ave., Hempstead, L. I., N. Y.

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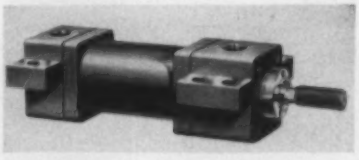

Double-Acting Cylinder

Item 458

Line of 2000 psi double-acting hydraulic cylinders has interchangeable foot lug, center lug, front

flange, rear flange, and clevis mounting steel end heads. Other features include short alloy steel tie bolts, automotive type piston rings, preloaded confined cylinder seals, preloaded ram packing, bronze ram guide, and unit seal ram wiper. Units are available in eight sizes, from 2 inches to 8 inches, with strokes up to 160 inches, and with dashpot cushions for either or both end heads. **Oilgear Co.**, 1560 W. Pierce St., Milwaukee 4, Wis.

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Ratio Relay

Item 459

Unit is designed for controlling a proportional relationship between two pneumatic signals when that relationship must be changed periodically. A typical application is for the adjustment of fuel to air ratio. Standard range of ratios is zero to 2:1; dial is calibrated for zero to 200 per cent. Linearity is ±0.5 per cent, dead spot is 0.1 per cent or less of output span with any ratio from 20 to 200 per cent. Input and output ranges are for 3 to 15 psig with an air supply at 18-20 psig. Model VRR (shown) is designed for panel mounting. It is clamped to a panel by the dial plate and ratio adjustment is made by turning the knob.

Also available is Model VMR, a multiplying relay applicable where proportional relationship between two pneumatic signals must be changed only infrequently, or for process control for which the relationship must be found after start-up, and is held constant. It can also be used for stepping signal pressure up or down between two related systems which do not use the same signal pressure ranges. **Republic Flow Meters Co.**, 2240 Diversey Parkway, Chicago 47, Ill.

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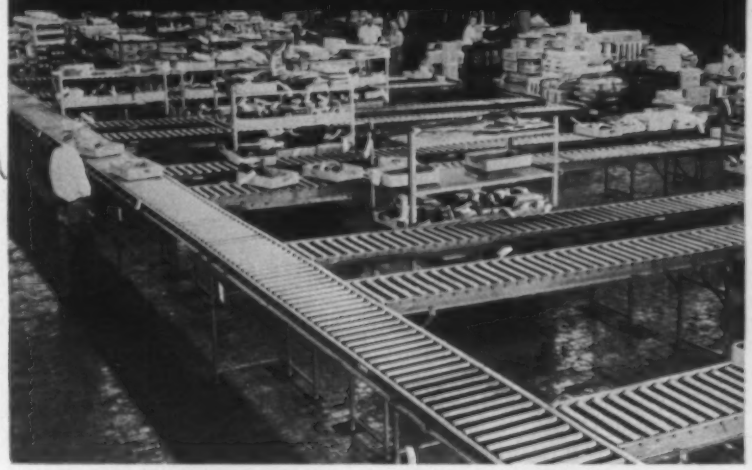
a complete line of
ROLLER CONVEYERS

engineered and standardized by

MATHEWS



Lines of roller conveyer used for packaging of tractor repair parts where orders are made up for shipment.

The Mathews line of roller conveyer is complete, with rollers ranging from 1-⅜" to 6-½" in diameter, and with capacities from 60 lbs. to 13,000 lbs. High quality ball bearings are used throughout.

Accessories such as turntables, hinges and switches are available from stock.

A full line of couplings and supports makes the installation of Mathews Roller Conveyer lines convenient and easy.

For latest information write for CATALOG 156

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MATHEWS
Over Fifty Years of Leadership in Mechanized Handling

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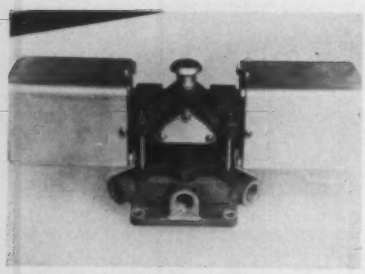

Plug-In Solenoid Valve

Item 460

Electrically actuated pneumatic valve has quick disconnect features, can be used as a control device for automatic setups using shop air. Model P/N 220155 consists of two parts: The base or manifold and the body or operating assembly. The base is permanently attached in place and the fluid lines are connected by pipe threads. Electrical leads are attached to a junction box forming an integral part with the base. The valve body is equipped with electrical prongs which fit into a female socket, while the body's fluid passages abut against corresponding openings at the base. A set of O-rings at the base is compressed by tightening four nuts which fasten the valve body, providing leakproof seals.

The entire valve mechanism can be replaced by plugging a new valve body onto its base and tightening the four nuts. Unit is rated for 115 v, 60 cycles ac, 100 psi, can withstand surge pressure up to 250 psi. **Whittaker Controls, Div., Telecomputing Corp.**, 915 N. Citrus Ave., Hollywood, Calif.

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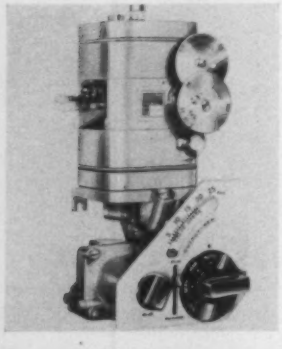
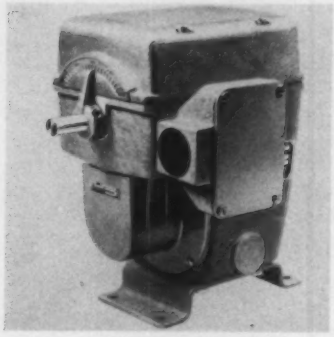


Pneumatic Controller

Item 461

Motion-balance pneumatic controller features a regenerative feedback circuit. By changing one subassembly, Model 53-P can handle both pneumatic and mechanical signals. The same design can be used with miniature or conventional instruments and provides a complete selection of controller modes. **Fischer & Porter Co.**, 255 Jacksonville Rd., Hatboro, Pa.

Circle 461 on Page 127



Electric Motor

Item 462

Device is capable of operating valves, dampers, and other controlled devices in accordance with signals generated by electric control instruments. Coasting of the motor is negligible, and over-travel protection is provided for the proportioning slidewire contactor so that disengagement takes place if travel limits are exceeded. An arc suppression circuit in the internal wiring protects switches and relay contacts that may be a part of the control system.

Two models are available. Each have two-position, floating, or proportional control forms. Model 831E2 has a rated output torque ranging from 1.5 to 31.2 lb-ft. Model 831E1 has torque rating ranges from 3.1 to 62.5 lb-ft. Motor is rated for 115 or 230 v, 50 or 60 cycles, or 115 v, 25 cycles. **Brown Instruments Div., Minneapolis-Honeywell Regulator Co.**, Wayne & Windrim Aves., Philadelphia 44, Pa.

Circle 462 on Page 127

Indicator Lights

Item 463

Splash-proof, moistureproof, miniature indicator lights are suitable for use on exposed panels. Two recessed rubber O-rings provide an inconspicuous watertight fit between the lens cap and case and between the mounting flange and panel. The steatite insulation around the large area center contact prevents swelling or jamming of the internal contact loading spring assembly. Rated for 6, 14, or 28 v, lights are available in 10 transparent and translucent colors, can be mounted in a ½-inch panel hole. **Hetherington Inc.**, Folcroft, Pa.

Circle 463 on Page 127

Snap Action Switch

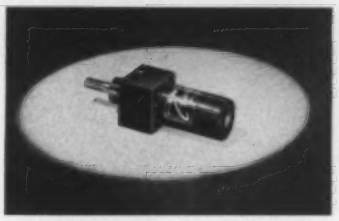
Item 464

Device features two isolated circuits with double break contact arrangements. Actuating force is 125 inch-ounces to trip and 190 inch-ounces for full overtravel. Release force is 38 inch-ounces. Unit operates when actuated 5 degrees in either direction from the neutral position, and is provided with 70 degrees safety overtravel in both directions. By use of a jumper wire across two of the terminals, the switch can be converted to a single circuit, open in neutral position, closed by clockwise or counterclockwise operation.

Three different types of switches are furnished. Model L100WNS is normally open in the neutral position. Clockwise operation closes one circuit by snap action and counterclockwise operation closes the other circuit by snap action, with spring return to neutral from

either direction of operation. Model L100WNR provides spring return to the neutral position from clockwise operation, but maintained contact in the counterclockwise operation. Model L100WNL provides spring return to the neutral position from counterclockwise operation and maintained contact in the clockwise position. **R. B. Denison Mfg. Co.**, 102 St. Clair Ave. N.W., Cleveland 13, Ohio.

Circle 464 on Page 127

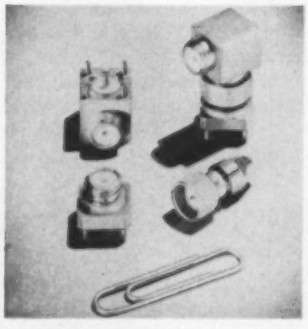


Clamp Type Cylinder

Item 465

Device can be used with toggle operations, spring return motions, die set strippers, pilot operations of valves, and opening of die sets. Clamp type air or hydraulic cylinder is constructed with synthetic piston packing to give an operating range between 55 to 250 F. Standard unit has a universal mount with threaded nose; and foot, front, or rear flange mounting. Pivot, trunnion, or clevis mountings are also available. **Carter Controls Inc.**, 2800 Bernice Rd., Lansing, Ill.

Circle 465 on Page 127

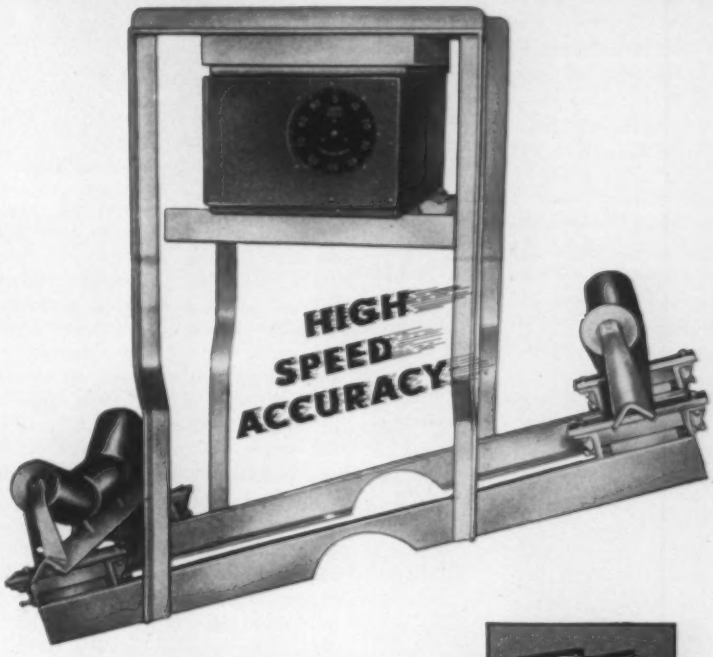


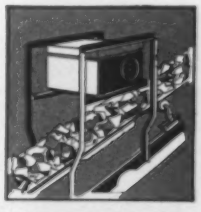
Coaxial Connectors

Item 466

Designed for use with coaxial cables and for mounting on printed circuit boards, miniature connectors are available in a 50-ohm con-

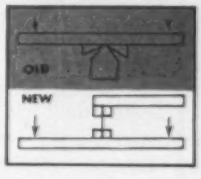
NEW Thayer Inventory Scale





Totalizes continuously and accurately any material being conveyed on an endless belt. Newly designed Thayer Scale fits over level or inclined systems at any location for direct or remote reading. Thayer Scales of 100 lbs. or 300 tons per hour capacity are available.

Recalibrates linearly with direct setting by just placing a known weight on the scale platform. The belt is not disturbed. No chains or involved calculations are necessary. Setting is positive, accurate, and long lasting.



Exclusive Thayer Plate Leverage System is guaranteed accurate for the life of the scale. There are no knife-edge pivots to wear down. Neither dust nor dirt nor vibration can affect its high accuracy. Thayer Scales are unsurpassed for simplicity and reliability under rugged conditions.

Write us about your bulk weighing problems for inventory or batching purposes.

THE Thayer SCALE

*THE THAYER SYSTEM OF PROCESS CONTROL BY WEIGHT

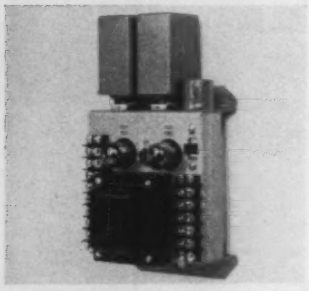
AUTOWEIGHTION

THAYER SCALE CORP., 5 Thayer Park, Pembroke, Mass.

Circle 687 on Page 127

stant impedance group, 50-ohm nonconstant impedance group and 93-ohm nonconstant impedance group. The series is rated for 500 v dc. The units shown are in the 50-ohm constant impedance group which includes a straight receptacle, right-angle receptacle, 360-degree swivel-type receptacle and an interchangeable mating plug. Height of the straight receptacle is 11/32-inch and mated length with the ¾-inch long plug is 63/64-inch. Right-angle receptacle is 7/16-inch high, mated length is 1-15/64-inch. **H. H. Buggie Inc.**, Box 817, Toledo 1, Ohio.

Circle 466 on Page 127



Control Relay

Item 467

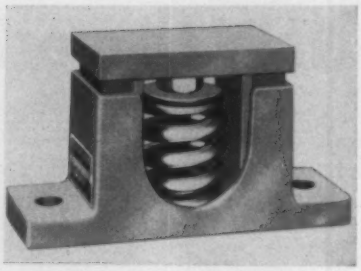
Unit is designed for operation with a transmitter using a company transducer. It is a versatile automation building block for precision measuring and control of linear displacement, machine tool motion, table indexing, package check weighing, and proximity control. The transducer is adjusted so that null position is at the required control point. The transducer and relay combination is sensitive to motions of less than 1/10,000 part of an inch, and as the armature of the transducer is moved off the null point a signal is generated having amplitude and phase definition. The relay is sensitive to this minute signal and either pulls in or drops out depending on the direction of the signal. Unit is rated at 115 v, 60 cycles. **Automatic Timing & Controls Inc.**, King of Prussia, Pa.

Circle 467 on Page 127

Spring Mounting

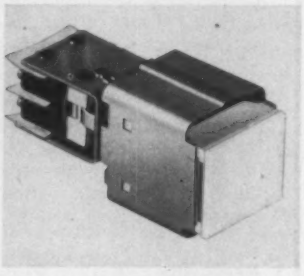
Item 468

Designed to stop vibration transmission from motor generator sets,



turbines, and air-handling units, mount is also effective in protecting machine tools, instruments, and other precision equipment against the vibration and shock generated by other apparatus. An access port on each side permits interior inspection and allows the springs to be changed in the field without dismantling the installation. The flat top is designed so that the unit can be placed in any position under a machine base to provide maximum support of the base. Tapped holes can be furnished in the top plate for bolting the equipment to the mount. Model LO is available in load-carrying capacities ranging from 150 lb to 23,000 lb. **Korfund Co. Inc.**, 48-15 32nd Place, Long Island City 1, N. Y.

Circle 468 on Page 127



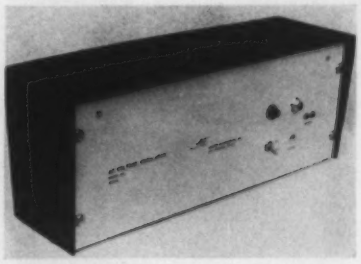
Pushbutton Panel Switch

Item 469

Unit is applicable for sequencing, movement-limit, start-and-stop, position-indicating, and other control operations; can be stacked or individually mounted on control panels or consoles. Model C6-53 combines a name-plate, a pilot light and a switching unit in a single assembly, features push on, push off alternate contact action. A snap-in button allows immediate lamp replacement from the front of the switch.

Some of the operating and indicating conditions which can be accomplished are: A variety of circuit arrangements for switch and pilot lights, different colored buttons for color coding, and colored lights for color monitoring. Unit has a mechanical and electrical life of 50,000 operations, is rated at 5 amps, 125/250 v ac, 4 amps res; 2.5 amps ind at 30 v dc. **Electro-Snap Switch & Mfg. Co.**, 4220 W. Lake St., Chicago 24, Ill.

Circle 469 on Page 127



Voltage Regulator

Item 470

Instrument, which is basically a variable tap autotransformer positioned by a push-pull solenoid, is suitable for use wherever a constant output voltage is needed. The output is independent of load power factor, input voltage, or load variations with rated specification.

The output voltage is rectified, filtered and compared to a standard voltage derived from a reference tube. The error voltage is applied to appropriate lead and lag networks. The outputs of the networks are used to control solenoids mechanically linked to the adjustable arm of the unit. Output regulation of one per cent is maintained for input variations ranging from 100-135 v ac and the output is adjustable between 110 and 120 v ac. **Armour Electronics Inc.**, 10800 Ventura Blvd., Studio City, Calif.

Circle 470 on Page 127

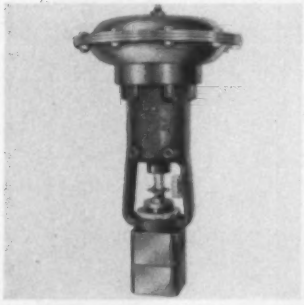
Industrial pH Meter

Item 471

Instrument is capable of automatically compensating for the change of slope of the pH-millivolt curve with temperature and shift of zero of the pH-millivolt curve with temperature. The meter is standardized in buffer at ambient temperature, irrespective of the temperature of the test stream. The design of the circuit and feedback

system provides a stability of ±0.02 pH per 24 hour period. Stability of the amplifier can be checked by use of a built-in check control. Model 28A can be used with any standard recorder. **E. I. L. Instruments,** P. O. Box 801, Philadelphia 5, Pa.

Circle 471 on Page 127

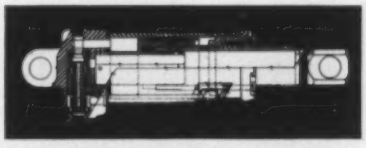


Control Valve

Item 472

High pressure control valve is capable of handling gases and liquids in high pressure drop, on-off, or throttling service, with dead-end shutoff. Model 505 has a pressure and temperature rating of 10,000 psi at −40 to 400 F. It is available with a direct or reverse action actuator with 3-15 and 6-30 psi instrument air range. Connection sizes are ½-inch and ¾-inch. **A. W. Cash Co.,** P. O. Box 551, Decatur, Ill.

Circle 472 on Page 127



Dual Speed Cylinder

Item 473

Employing a single pump and motor, dual speed hydraulic cylinder provides alternating speed and power cycles in the same unit. It is applicable on hydraulic presses and other equipment where fast opening and closing strokes alternate with full power work stroke, or where working components are moved or positioned during non-working strokes and where increased speed of such movements results in a reduction of over-all cycle time.

Device is equipped with automatic valving. The shift from low-power, high-speed to high-power, slow-speed stroke is caused by means of spring loaded valves in the head, responding to increases and decreases in system pressure. The cylinder includes three chambers. Two primary, high-speed chambers oppose one another, and are located around a third which is the power chamber. Normally, the cylinder operates on the outer advance chamber. When load increases to the point that the power of that chamber is insufficient, the inner chamber automatically becomes operative to provide maximum power at slower

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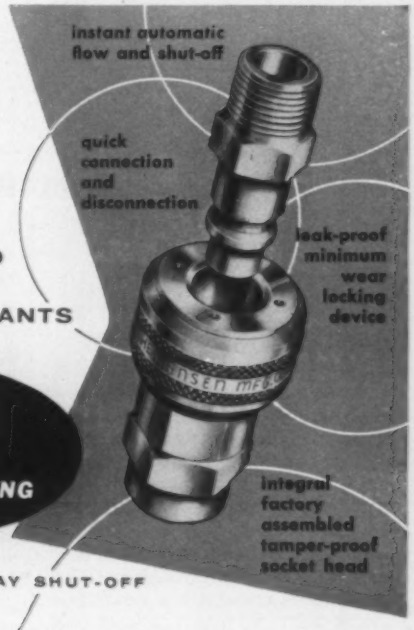
QUICK-CONNECTIVE
PUSH-TITE COUPLING


instant automatic flow and shut-off
quick connection and disconnection
leak-proof minimum wear locking device
integral factory assembled tamper-proof socket head

ONE-WAY SHUT-OFF

Locking pins in Hansen Push-Tite Coupling Socket afford large area contact with Plug, thereby preventing wear and subsequent leakage.

The ability of Hansen Push-Tite Couplings to withstand severe service—with practically no maintenance—has been thoroughly proved by years of hard, everyday use in thousands of plants. The "socket head", which contains the locking device, is factory assembled into a rugged integral unit which cannot be readily injured or have component parts lost by casual tampering.

To connect the Coupling, you merely push the Plug into the Socket with one hand. Flow is instantaneous. To disconnect, push back sleeve on Socket—Coupling disconnects. Flow is shut off instantly and automatically.

QUICK-CONNECTIVE FLUID LINE COUPLINGS for

AIR • OIL • GREASE
HYDRAULIC FLUIDS • WATER
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Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen Quick-Connective Couplings. Write for your copy.

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SINCE 1915 — QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

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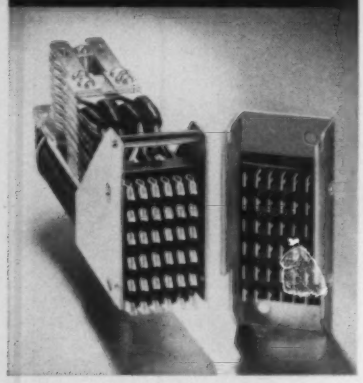
Circle 688 on Page 127

STROMBERG-CARLSON

Type "A" Relays with Plug-in mountings



For fast, easy removal and replacement you can get Stromberg-Carlson Type "A" Relays with *plug-in mountings.*

The Stromberg-Carlson Plug (illustrated above) automatically locks the relay in place and guarantees a low-resistance connection between plug and socket. Its 36 terminals provide enough connections for practically all relay applications. Coils and contacts are wired to terminals as your needs dictate. Contacts can be furnished in silver, palladium, gold alloy or palladium-silver alloy.

Spring combinations possible with this assembly are 17 Form A or Form B; 10 Form C or Form D.

Also available in an "A" Relay is a plug used with commercial radio type sockets. It can mount relays with 8, 9, 12 or 20 connections.

For technical details and ordering information, send for Bulletin T-5000R, available on request. Write to:

S-C STROMBERG-CARLSON

STROMBERG-CARLSON

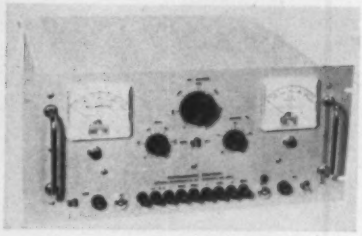
A DIVISION OF GENERAL DYNAMICS CORPORATION
TELECOMMUNICATION INDUSTRIAL SALES
111 Carlson Road, Rochester 3, N. Y.

Electronic and communication products for home, industry and defense

Circle 689 on Page 127

speed. When the load drops, the outer advance chamber takes over again, by-passing to the power chamber in such a manner that it is full at all times and ready to deliver additional power as required by the work. **Crown Engineering Corp.**, 4700 Washington Ave., Houston 8, Tex.

Circle 473 on Page 127



Power Pack

Item 474

Instrument can be programmed from a remote location by means of an ordinary resistor or rheostat. For each 500 ohms shunted across the programming line, the power pack furnishes one volt. Resistance can be varied continuously or in steps. Model 236A (shown) is rated at zero to 600 v dc at a maximum current of 200 ma. It also has a zero to 150 v dc, 5 ma bias supply and a 6.3 v ac, 10 amp filament supply. Another unit (Model 235A) has a programmable output capable of furnishing 500 ma at any voltage between zero and 600. Both devices are applicable in automatic test facilities. **Electronic Measurements Co. Inc.**, Eatontown, N. J.

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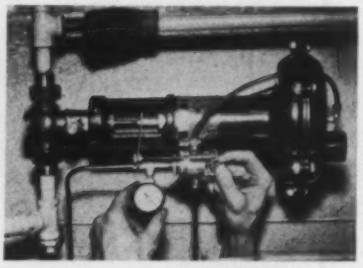

Pneumatic Relay

Item 475

Adaptable for the control of pneumatic motors and valves, adjustable positioning relay can be installed with a screwdriver and wrench. The device can be fitted to 3, 4, and 6-inch pneumatic motors, and to 8 and 12-inch diaphragm valves. Relay can also be used to adapt existing motors and valves to increased load conditions. The adjusting screw on the unit can be set to delay operation of the motor or valve until control pressure reaches a desired point between 2 and 15 psi. The distance of motor or valve stem travel for various changes of control pressure can be adjusted between 2 and 13 psi. Maximum air pressure is 25 psi. Steady performance is furnished from 20 F to 180 F. **Powers Regulator Co.**, 3434 Oakton St., Skokie, Ill.

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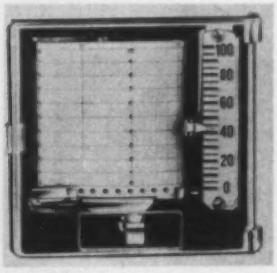


Recording Pressure Gage

Item 476

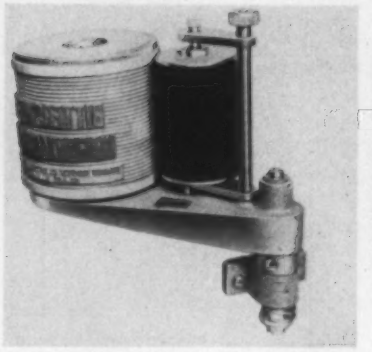
Instrument uses a 3-inch strip chart, is offered in ranges from zero to 3 psi up to zero to 60 psi. The recording chassis is interchangeable, can be plugged in from the front of the panel. Different versions of the unit are furnished. One will record and indicate one pressure measurement, a second will record and indicate one while recording a second, and another records and indicates one pressure and indicates the second. All models are available with either pneumatic or electric chart drives, in a variety of chart speeds. **Bristol Co.**, Waterbury 20, Conn.

Circle 476 on Page 127

Automatic Case Marker

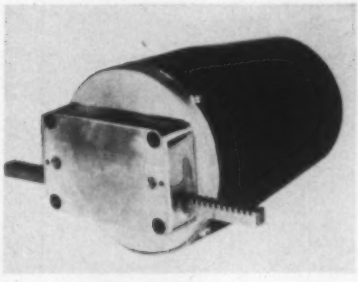
Item 477

Conveyor and case-sealer attachment is designed to automatically mark and code shipping cases. Unit is adaptable for imprinting the top, bottom, or either side of cases of



various dimensions, will accurately spot-print codes or other copy legends in almost any location on the case. Imprints up to 3 inches in depth can be obtained. The swing-out mounting allows easy type changes and refilling of the ink reservoir, which holds a week's supply. The base is constructed to securely hold rubber type or dies on the printing wheel. **Adolph Gottscho Inc.**, Hillside, N. J.

Circle 477 on Page 127



Linear Actuator

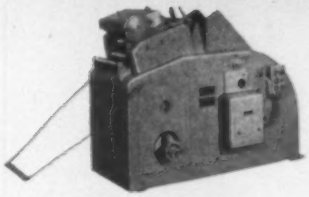
Item 478

Positioner can be employed for nuclear control, machine tool control, or other positioning applications where linear motion must be proportional to a control signal. Unit has a gear motor with a built-in potentiometer which produces a remote indication of position. Output from the unit is through a precision rack and pinion with thrust forces up to 1000 lb and with a variety of stroke lengths and stroking rates. Actuator is available with single phase 115 v motor, 3 phase 220/440 v motor and for 2-phase control circuits. Open, totally enclosed and explosion-proof enclosures can be furnished. They can be face, bracket, foot, or pivot mounted.

For remote control applications, a position setter can be used with

LITTELL

COIL CRADLE-STRAIGHTENER UNITS



No. 408H-C-20
CRADLE-STRAIGHTENER UNIT

Variable Speed Drive for Any Speed, 12 to 72 f.p.m. Cradle holds 2,000 lb. coils. 5-roll straightener handles stock 8" wide x .187" thick. Wider units for 42" wide x .046" thick. Available with Electric Clutch and Brake or with Oil Gear Drive. Some models of this size and type in stock for immediate delivery.

No. 638D-C100
CRADLE-STRAIGHTENER UNIT

Variable Speed Drive For Any Speed From 18 to 108 f.p.m. Air operated Cushion in Cradle eases coils up to 10,000 lbs. into position aligned with straightener head. 5 power-driven straightener rolls handle stock 14" wide x 1.87" thick or 42" wide x .125" in thickness.

SEE OUR CATALOG IN SWEET'S

HOLD Heavy Coils In Small Space

ALIGN Coil With Straightener

STRAIGHTEN At Any Speed

AUTOMATE All These Functions

All Standard Littell Cradle-Straightener Combinations have 6 to 1 Variable Speed Drives to supply straightened stock evenly at any speed within their range. Arm loop control automatically keeps proper slack in straightened stock moving to using equipment. Cradles handle any I.D. coils.

For High Speed — Sudden Stop Operation, an Electric Clutch and Brake can be furnished on the output shaft of the Variable Speed Drive. This feature eliminates starting torque strain. The Variable Speed Drive stays in running position, unaffected by the upward-downward movement of the loop control arm.

Oil Gear Drives can be furnished on these units for extra smoothness and arm controlled straightening speed within a range of 0 to 100 feet per minute.

Delivery is Good from the *larger* Littell Plant equipped to speed production.

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or write for free catalog.

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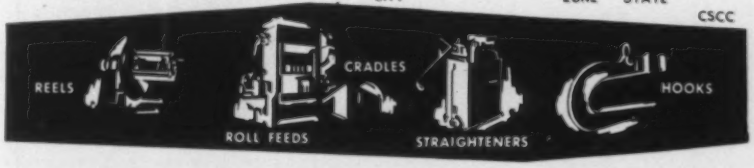

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linear position corresponding to dial setting. With precision multiturn potentiometers, positioning accuracies of ±0.004 inch are provided for a 10 inch stroke. When furnished with a suitable controller, linear position can be governed by a control signal originating from any transducer, with proportional adjustment available. The control signal can originate from a 3 to 15 psi signal, a 0.5 to 5 ma signal, or from a variable frequency source. **Jordan Co.**, 3235 W. Hampton Ave., Milwaukee 9, Wis.

Circle 478 on Page 127

Voltmeter or Converter

Item 479

Instrument is designed to operate either as a digital voltmeter or as an analog to digital converter; is capable of 2000 completely independent conversions per second. When used as a digital voltmeter, the speed is so fast the visual display appears continuous. After one conversion has been made, it is ready to make another whenever commanded by an external trigger.

When used as an analog to digital converter, the instrument provides four outputs: Visual, one-out-of-ten, binary-coded decimal, and arbitrarily coded decimal. The operator chooses his own code. To change codes requires only that the slides containing the matrix be pulled and the plug-in jumpers be inserted. The printed circuit cards used in the instrument prevent errors in that they can be inserted only in the location provided. **Adage Inc.**, Dept. P, 292 Main St., Cambridge, Mass.

Circle 479 on Page 127

Press Overload Control

Item 480

Device is capable of protecting high speed presses and dies against misfeed or doubling of material. As the crankshaft of the press deflects slightly with each stroke, it deflects the flywheel. If two thicknesses of stock enter the die through a misfeed, the deflection is greater than normal. The control detects this deflection on stock 0.010 inch thick and heavier, and stops the machine. The device can be wired into the emergency stop circuit on any press with an air clutch. **Precision Welder & Flexopress Corp.**, 3520 Ibsen Ave., Cincinnati, Ohio.

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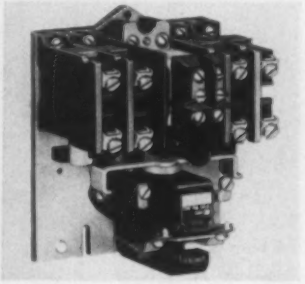

Latch Relay

Item 481

Mechanically-held latched-in relay requires no extra vertical height, can be grouped in rows as needed. Poles and latch units are individually removable and replaceable without disturbing other poles or their wiring. All access for wiring, inspection of contacts, and removal or replacement of poles or latch unit is from the front. Relay is available in nine models with from two to ten poles. Latch relays with up to six poles are furnished without double-decking. Contact may be converted between normally-open and normally-closed in the field without extra parts. **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio.

Circle 481 on Page 127

VECO THERMISTORS, VARISTORS RATED HIGHEST QUALITY BY INDEPENDENT LABORATORIES

What's behind this quality? — it's VECO's ever-constant research, development and engineering program, designed to keep abreast of today's fast-changing industry. Backed by one of the country's largest and finest equipped plants, VECO works hand-in-hand with customers to improve existing products and develop new applications utilizing Thermistors and Varistors.

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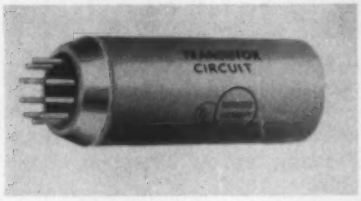
Circle 691 on Page 127

Plug-in Circuit

Item 482

Line of 250 kc plug-in circuits uses germanium transistors, is applicable in timing, control, and computer systems. Circuits are totally enclosed and when mounted with a 1-inch spacing, total space required is 1 square inch per case or 2.18 cubic inches per case. Cases can contain more than one circuit,



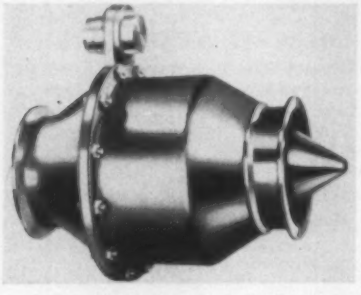
and can be opened for repairs without special tools. Units feature complete intercircuit compatibility, low power consumption, and can be used with standard hardware and sockets. **Engineered Electronics Co.**, 506 E. First St., Santa Ana, Calif.

Circle 482 on Page 127

Poppet Valve

Item 483

Device can be applied on operations which require closure on either power or pneumatic failure. It can be used where a minimum operating pressure of 10 psig exists and uniform timing is 5 seconds maximum. A 400 cycle or standard 26 v dc solenoid can be used with the two-position valve. Ex-



ternal leakage for a two-inch valve is 0.02 lb/min at 150 psig and 600 F, with valve closed. Internal leakage is 0.07 lb/min at 150 psig at 600 F. Ambient temperature range is − 65 F to 300 F with continuous duty and − 65 F to 350 F with intermittent duty. **Barber-Colman Co.**, Rockford, Ill.

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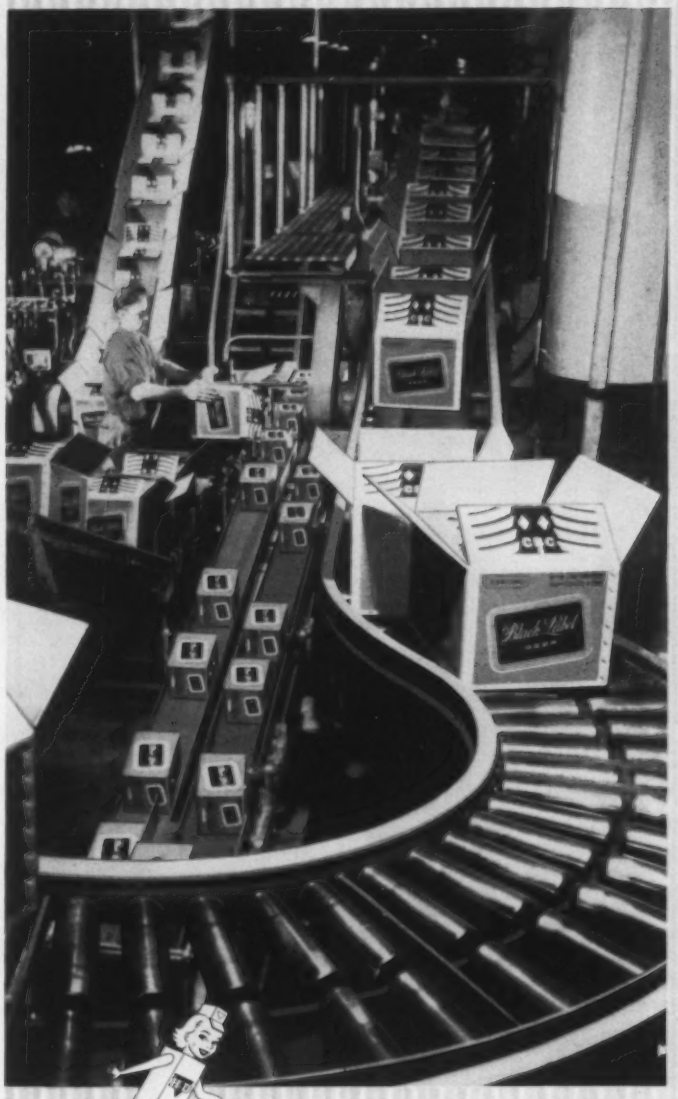

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Circle 692 on Page 127

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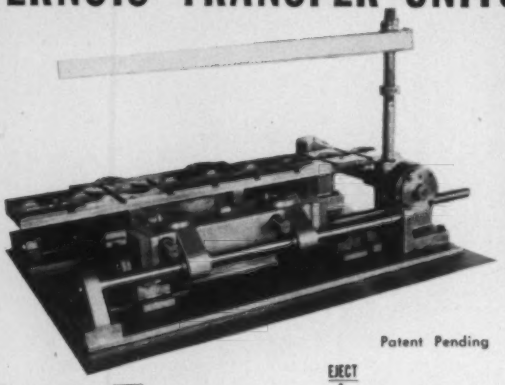
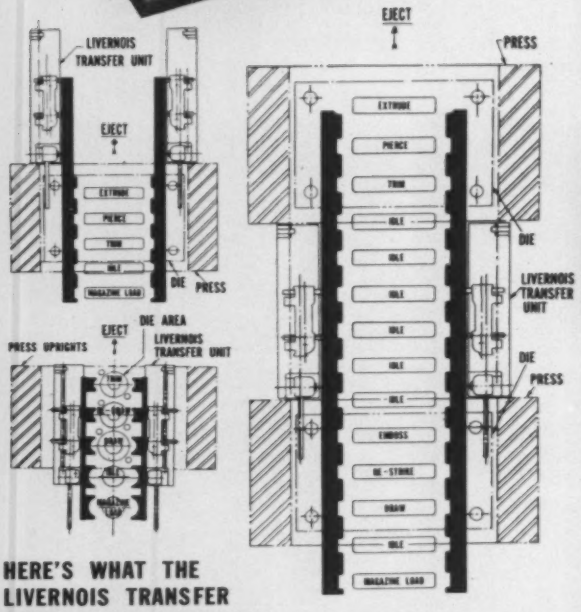


Patent Pending



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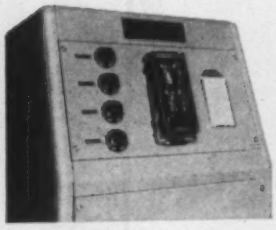

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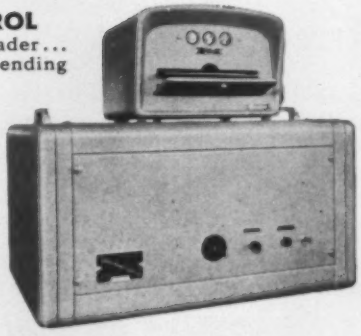

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A compact dial incorporating a weight selector and selection switch for each ingredient to be delivered to the scale's weighing hopper. Number of ingredients handled is limited only by plant area available.

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Circle 694 on Page 127

AUTOMATION IN THE REFINERY

By R. E. SUTHERLAND
Vice President
Universal Oil Products Co.

THE REFINING PROCESS, to be efficient, requires continuous operation—hour after hour, day after day, for as long as possible for the equipment to function. Handling the considerable amounts of material which flow through a refinery pushed the industry toward automation very early. Fortunately, refining processes are relatively easy to control—with the right kind of tools—and the economic incentive is strong. To put it a different way, it's easier to put automatic controls on a refinery than it is to build an automobile or run a coal mine with machines. And, with the tremendous volume of gasoline and other products made by a single refinery, and the vast amounts of equipment and auxiliary raw materials—water, fuel, etc.—needed, a small increase in efficiency pays big dividends.

Instruments And Controls

Essentially, petroleum refining requires control over temperature, pressure, and the rate at which material flows through the equipment. It also requires that the amount of material in storage tanks be known from time to time. The first thing the oil industry did was determine ways to measure the factors affecting its performance. Thermometers, thermocouples, and various types of gauges were developed. So were meters to measure flow rates, and devices to measure liquid levels.

Controls were developed more slowly. The oil industry first controlled pressures and flow rates by hand valves. A man would read his meters, know from past experience that changes should be made and would take a few turns on a handle. Later he would read the meter again to see if he had turned the valve enough, too much, or too little.

Similarly, he would read a thermometer and cut down or increase the fuel going to the furnaces. It was all quite simple—for an experienced operator who had the feel of his process unit.

Chemists and engineers began working out new ways to make better oil products. — Unfortunately, these new ways required closer control over the heat, pressure and flow variables. In the refinery, measuring instruments were installed to take closer looks at what was happening in the process units. They began to make permanent records of temperature, pressure, and flow so that these records could be studied to obtain information on the *rates of changes*. They gave the operator a way of seeing what happened when he turned his valve and how long it took for his action to affect the process.

Instrument systems became more sophisticated, and so did the operators. Recording devices were placed conveniently to the valves controlled by the operator to eliminate needless running around. And, since a refinery is often a spread-out plant covering hundreds of acres, recording instruments and actuating devices were placed together in a central control house.

It was as if the inspection department of an automotive engine plant could communicate instantly with the operator of each individual lathe. As a result of remote measurement of each crankshaft as it came out of its lathe, the inspection department could notify the lathe operator when to adjust his machine to assure production to desired specifications.

Data Transmission

With the refinery control and actuation devices located in a central spot remote from individual process units, means had to be provided for compensating for the time lag involved. For technical reasons, compressed air was used to convey meter readings to the control room and corrective instructions back to the valves. This required that the operator have a "feel" for the unit to anticipate how long it would take a corrective action to show up in the refining unit's performance.

Very recently—within the last few years—this problem was solved by the installation of an electronic transmission system. So now the problem of measuring operating conditions that a human couldn't see or feel has been solved. So has the problem of making the proper corrections.

Quality Check

But there's another problem. With modern refining techniques, you often have to know more than what's happening inside the unit. You have to keep constant watch on the product to be sure that you're making exactly what you want. There are some highly technical reasons why you can't decide in advance what you want to make and then look up a chart that tells what temperature, pressure, and flow is required. Refining units are subject to variations during their operation that often require different amounts of heat,

for example, under different process conditions.

It is possible to make intricate devices to measure these circumstances, but the easiest way is to determine whether you're making the product you want. Therefore, as controls and actuators were being developed over the years, methods of rapid measurement of product quality were developed. Today, in the modern refinery, the operating conditions are measured and recorded in permanent form. The product is also measured and the information is used as a guide in controlling the operation.

Future Directions

There is considerable debate within the industry as to what step should be taken next in automation. Technically, it is quite feasible now to take the human operator out of the control loop. In other words, it is possible to measure what is happening inside a refinery, measure the properties of the product made by that refinery and take the proper corrective action without sending the information through the human mind. Computers make this possible.

It is theoretically possible to design a computer that can be taught what to do if the gasoline stream has, let's say, too much octane or too little octane. True, it requires a human mind to program the computer, but once done, the computer never forgets. Whether the cost of installing and training a computer to follow a rigid set of instructions is justified is another question.

The oil industry is a fast-moving business, and highly competitive. Its methods change, its processes are constantly improved. Perhaps it will decide computers are too inflexible, that it is too hard to break old habits, and that a skilled human operator is the best device to rule the control house.

Despite what happens in the next few years, automation will continue to advance throughout the refinery. We know that some processes in use today would not have been possible without the precise measurement and control made possible by automation, with its sensing devices, feedback circuits and actuators. Worker productivity has steadily increased, partly because relatively few men can guide an intricate continuous process, but more importantly because automatic controls have made extremely large units practical. New processes are coming along to make purer chemical combinations for use as fuel. And we in the industry are convinced that economical production of these fuels will be impossible without corresponding improvements in the systems that will control the equipment making the fuel.

The refining industry has lived with the automation concept for nearly 40 years. Refining became a continuous process operation when the industrial production line was in its infancy. It has laid the foundation for many new automation techniques that are going to be very important in all industries.

From a talk entitled "An Experienced Industry Looks At Automation" presented at the University of Chicago Conference on Automation, Chicago, April 1958.

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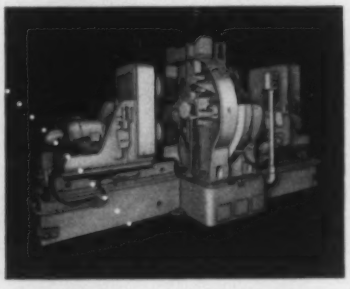

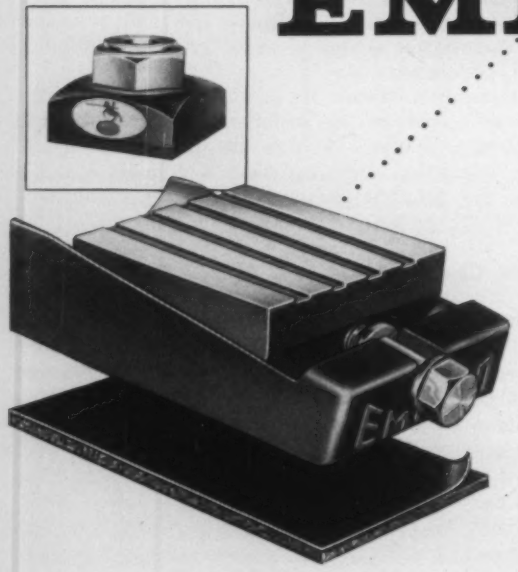

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TEXTILE MACHINERY PROGRESS

By KENNETH R. FOX
Fabric Research Laboratories Inc.
Dedham, Mass.

IN CONSIDERING textile machinery generally and fabric processing equipment specifically, it is often concluded that little significant progress has been made since power was first used as a motivating force. This view no doubt stems from the similarity in appearance as well as the basic parts and motions of present equipment compared to its ancestors. A card today, for example, looks similar to cards of fifty years ago; a loom has many points of similarity; and the same thing may be said of washers, dye tubs, nappers, shears, dryers, etc. Consequently, textile machinery manufacturers are often accused of being backward, too conservative and unwilling to pioneer in new ideas and concepts.

Better Equipment Available

What, then, has the textile machinery manufacturer accomplished to answer this criticism? Although it is not the thesis of this discussion to defend the machinery manufacturer, it is nevertheless felt that in certain areas he has done a good job. Two specific areas are cost reduction through greater productivity and quality improvement. In yarn preparation certain processes have been eliminated, higher speeds are employed, and larger packages are being made. At the same time, yarn quality has been improved. Systems have been made much more versatile, handling wide ranges of fiber lengths and deniers. Looms have been made more automatic, protection and stop motion devices have been substantially improved and loom speeds increased significantly. Better quality greige goods has resulted.

In the wet and dry finishing field, cost reductions have been realized by either process elimination or combining separate steps into range operation. Nappers are more efficient, shears are more accurate, dryers are more economical—all of which produce better quality at cost savings.

Machinery is better built today and requires less maintenance and repairs. Styling has been greatly improved because it is recognized this feature is not only a factor in selling machinery but also in encouraging better work on the mill floor. Progress has certainly been made. A recent brochure prepared by the American Textile Machinery Association, under the title of "Profit Life of Textile Machinery," contains a good summary of recent machinery developments.

Cost Versus Quality Improvement

From an entirely different point of view, an intriguing consideration was posed recently at our company as to whether or not textile machinery was being engineered and priced out of the market. Would it be better for certain basic products especially in the mechanical fabrics field to have available a stripped-down set of machines to produce fabrics where *quantity*, not *quality*, was more important? Or in the staple fabric field, would it be more practical and at the same time more economical to employ machines which are

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FULL RANGE SPEED CONTROL
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Write for Bulletin R-313.

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Circle 696 on Page 127

less flexible but still adequate to turn out staple fabrics by the mile? Where is the balance between machinery costs and value imparted to the fabric? The answers to these questions are not known, but it might make a very interesting study with worthwhile results, to look into the matter.

Future Developments

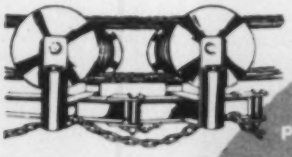
Fabric processing equipment of the future will certainly produce product at lower costs and better quality. It is only a matter of time before shuttleless looms using outside filling supply packages will be generally available at lower prices. Multiple pick insertion seems a possibility. In the finishing plant, more combined operations will result. Automated systems will be employed more widely, especially in range drives. It is conceivable that the use of reactant dyes will permit entirely new methods and machinery for dyeing. In the drying, curing, aging, heat setting, and similar operations where elevated temperatures are involved, the use of fluid beds as heat exchangers seems probable. In the same way that continuous, open width washers are available, it seems more than likely that an open width, continuous fulling mill will be perfected. Machines which will produce new textures of materials having novel visual effects to entice the buyer will certainly come along.

Washability, which includes shrinkage control, is becoming more and more demanded by the American public. Consequently, it is felt that increased activity will be required in the field of tension control to minimize shrinkage from processing strains. Mechanical and chemical methods for stabilizing fabrics represent fruitful areas for development work. This is especially true in the woolen and worsted field where a universal anti-felt treatment is necessary. Solvent systems for wet processing seem quite likely. In short, opportunities in the fabric processing machinery field are numerous, and significant developments can be contemplated perhaps sooner than anticipated.

Emphasis on Engineering

Engineers who are interested in the textile industry can certainly look forward to a stimulating and challenging future. This applies to the design and construction of machinery as well as its operation. There will be an increasing need for upgraded labor who will be more like operating engineers rather than machine attendants. Too many machines in textile mills today are being run "cookbook style" rather than from a basic understanding of the engineering principles involved. It should be the goal to employ the concepts and philosophies of sound engineering to further progress in the textile industry.

From a paper entitled "Survey and Trends in Fabrics and Fabric Processing Machinery," presented at the ASME Textile Engineering Conference, North Carolina State College, March 1958.



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Circle 697 on Page 127

Circle 698 on Page 127

RECENT IMPROVEMENTS IN HYDRAULICS TECHNOLOGY

By ROBERT ERSKINE
Chief Engineer, Machinery Hydraulics Div.
Vickers, Inc.
Detroit, Mich.

DURING the last twenty to twenty-five years there have been material advancements in the design of hydraulic controls and components. It is the purpose of this presentation to outline some of these advancements and to comment on the state of the art as it exists today. Areas of needed development will also be discussed.

Reservoirs And Pumps

In earlier years hydraulically actuated machine tools used reservoirs that were integral with their machine bases. Modern reservoir construction provides features not found in these earlier designs. Improvements include better radiation of heat, handhole covers for cleaning, oil level indicators, inlet strainers, accessible drain connections, and lift hooks to facilitate handling.

In the area of pump design the trend is toward wider adoption of replaceable pump cartridge types which facilitate maintenance and reduce downtime. Gasket-mounted pumps which have their inlet and outlet ports on a common mounting surface are becoming increasingly popular, particularly for variable displacement types used for metal cutting applications requiring 1000 psi and under. Another improvement in pump design is the elimination of grease fittings and grease-relief fittings. Aside from reducing maintenance costs this provision eliminates the problem of over-greasing.

Pressure Controls

With the evolution of pressure controls there is now more widespread adoption of two-stage, or pilot operated, types. These are rapidly replacing direct acting, spring loaded, poppet types.

Modern pressure controls are designed so that the maximum rated pressure may not be exceeded by about 10 per cent. They are constructed so that if the adjusting screw is removed the result will not be an unwanted bath. Handwheels can be provided for adjustment as well as means for sealing the adjustment points in accordance with JIC recommendations. Adjustment locks can be provided instead of handwheels.

Other advancements in the design of pressure controls include chatter-free remote control valves, pressure switches that have adjustable differentials between cut-in and cut-out, and improved sequence and foot valves.

Flow Control Valves

Today, a wide variety of flow control valves is available to the machine designer. They range from simple, noncompensating, needle and check valves to more sophisticated traverse-feed units. Lying between these extremes of refinement, and probably most popular, are

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Only one operator simply guides the bags as the power conveyor stacks to full height anywhere in the box car or truck. All changes in position are electrically or hydraulically controlled so that the flow of bags need not be interrupted once car loading starts, up to 90 tons per hour in 100 lb. bags.

Power-Curve operator drives the conveyor across the loading dock and into the car end with push button power, around corners over any U or S path. Controls of flexible conveyor surface are independent, reversible for loading or unloading trucks and cars. Stacker hoist lifts belt from 18 in. to 72 in. above floor. Rough-top belt shoots bags or packages into place taking all the work and lifting out of loading operation. Stacker unit disconnects from flexible conveyor. Write for complete catalog, typical layouts in your industry, list of installations, etc.

POWER-CURVE CONVEYOR CO.

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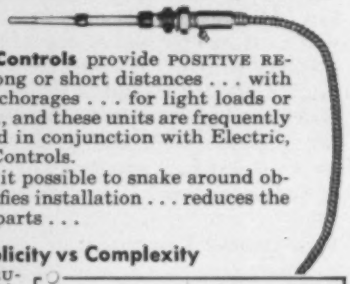
Circle 698 on Page 127

Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

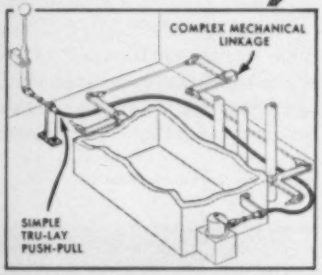


Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

Immunity to Vibration makes these TRU-LAY PUSH-PULLS ideal as Remote Controls on shakers and other vibratory products.

Complete Protection Against Dirt and Moisture is a big factor in the use of this unit on machinery in Coal Mines, Cement and Steel Mills, Oil Fields and in many other industries.

Corrosion-Resistance of the unit, plated or with Stainless Steel construction as required by the use, has led to many applications in the Marine Field . . . salt water or fresh. Supplied with a rubber cover the unit operates effectively even when conduit is COMPLETELY IMMERSED.

Lubrication of the inner working member is for life.

Temperatures as low as —70°F will not hinder the proper operation of this unit, and it is thoroughly effective even in the extreme high temperatures encountered on Jet Engine, Furnace Door and Glass Furnace Damper control applications.

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Push-Pull DATA FILE

TRADE MARK

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pressure compensated, in-line type, nonadjustable flow control valves. Pressure and temperature compensated flow control valves with integral locks are also widely used. Temperature compensation is principally applicable to small (¼-inch) flow control valves, being most valuable in the flow range of, say, 10 to 30 cubic inches per minute.

Accurate maintenance of feed rates is becoming more of a factor in manufacturing processes. In the use of carbide-tipped cutting tools, for example, it has been shown that their life is related to uniformity and rate of feed.

Directional And Pilot Valves

There have been a great many changes in the concept and design of directional control valves. In the metal cutting field, threaded-connection, manually operated valves have given way to small, short-stroke, pilot operated valves. They may be actuated by mechanically operated pilot valves or, more popularly, by solenoid operated pilot valves. Older types of direct solenoid operated valves had massive solenoids and long strokes. Short service life resulted from the shock inherent in these designs.

Pilot valves have also been refined to conform to industry requirements for more foolproof, easily maintained constructions. The refinements include tight-fitting solenoid covers that are chained to the valves to prevent their loss. Covers hold the solenoids to their valves so that the valves will not operate without covers. Coil burnouts caused by incomplete seating of the solenoid due to the presence of chips and dirt are thus avoided.

Some pilot valves are equipped with manual actuators for "jogging" action. Others are constructed so that when the solenoid is removed the valve does not come apart, that is, the solenoid does not hold the hydraulic valve together. Wire storage space is provided on many of these units and this reduces costs by facilitating installation and maintenance of the electrical portion of the circuit.

Easy Maintenance Demanded

The design of all hydraulic components has been influenced to a great degree by stress placed on ease of maintenance. To highlight this need, in one plant the maintenance routine for a power unit required the presence, first, of an electrical maintenance man to disconnect the electric motor, then a machine repair man to remove the bolts which held the cover to the reservoir, next a crane operator to lift pump and motor off, and finally a hydraulic maintenance man to supervise the draining and cleaning of the reservoir. All of these men would be called in reverse order to reassemble the unit!

Maintenance requirements have also influenced the widespread adoption of gasket mounted units, particularly 4-way valves, flow control valves, sequence valves, counterbalance valves, and pressure reducing valves. The task of the control component designer has been eased to a large degree by availability of the O-ring seal which was first developed for aircraft applications.

The biggest objection to oil hydraulic power trans-

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mission is the presence of leaks. As component manufacturers we classify leaks into two categories—those occurring in components and those originating at connections.

The former do not constitute a pressing problem; any hydraulic component that is properly designed, manufactured, and applied within gunshot of its published recommendations does not leak. What do leak are the connections between units.

Some of the latter types of leaks can be overcome by assembling gasket-mounted components to panels or subplates containing circuit passages produced by brazing or drilling. This is quite an acceptable practice provided the circuit is a proved one which will not require modification.

Even in this type of construction, however, the trouble is still with us in the form of the connections from such panels to the hydraulic power unit and to the machine to be actuated.

The Society of Automotive Engineers has recently introduced a straight-thread O-ring type fitting similar to the *AN*-type fittings that have long been standard in aircraft applications. Fittings of this type are vastly superior to tapered pipe threads as regards leakage. Even though pipe taps may be specially ground, and pipe plugs may have deliberate mismatch in their tapers to assure interference, it is still often necessary to use sealants at the connections.

It is true that valves and subplates provided with ports to match the new SAE straight-thread fittings are a bit bulkier and a bit more costly to produce than units employing tapered pipe threads. Perhaps as a result, machine tool manufacturers have been extremely slow in adopting this advance. This is an instance where the hydraulic control industry is ready, but evidently the user would rather keep on complaining about leaks than pay the builder anything additional for providing a leakproof system.

Better Components

In addition to solutions for leakage problems there is a real need to develop longer lived valve actuating components such as solenoids. In this area, the oil-immersed type recently introduced by one solenoid manufacturer may be the answer. Another need is for control valves particularly designed for actuation by low-powered static switching elements.

The continuing development of electrohydraulic servo valves for tape controlled automatic machinery will be accelerated as the cost of such equipment is reduced to the point where it is economically feasible for common use. Along with servo valve development will be the need for high capacity and pressure full-flow filters, since servo valves are much more subject to malfunctioning in the presence of dirt in the system than are less sophisticated types of valves.

From a paper entitled "Defense For Hydraulic Controls" presented at the Fifteenth Annual Machine Design Conference sponsored by the Cleveland Engineering Society, Cleveland, Mar. 1958.

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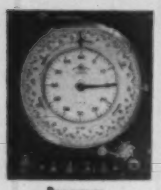

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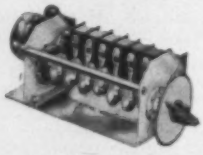

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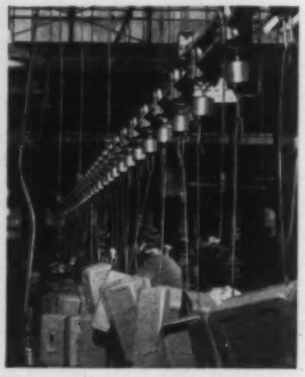

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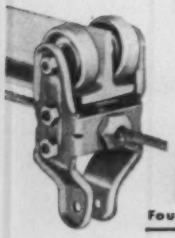

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Single sheets of material are fed through a pair of rollers. Upper roller is power-driven and lower roller is friction-driven by the bottom surface of the sheet. When two or more sheets reach the rollers, the bottom sheet slips and causes the friction roller to stop rotating which disables the feeding mechanism. Patent 2,813,717 by James S. Mentzer, assigned to Cummins-Chicago Corp.

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ELECTRIC SELECTIVE APPARATUS

Magnetically arrested columns of magnetizable elements are selectively released by demagnetization of a ferromagnetic circuit. Patent 2,817,703 by Irving Naxon.

PICKLE SORTING MACHINE

Pickles of varying length feed past sorting stations in individual pockets. Pickle knocker on a rotating shaft hits projecting end of a pickle and tips it out of the pocket at the sorting station corresponding to the length desired. Patent 2,818,975 by Earl J. Van Holten, assigned to J. G. Van Holten & Son Inc.

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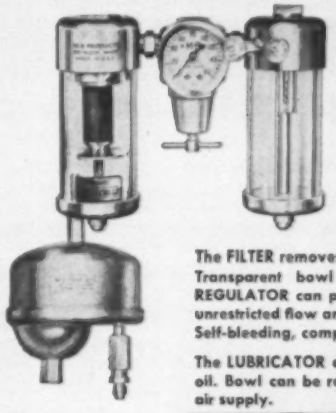

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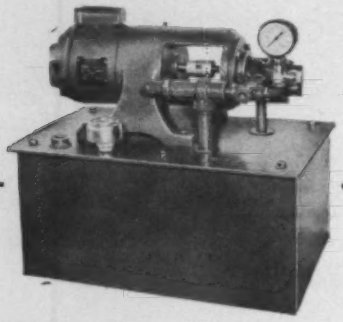

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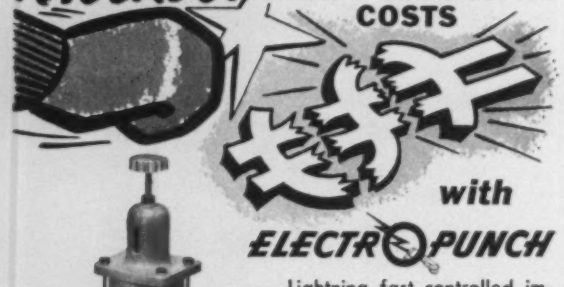

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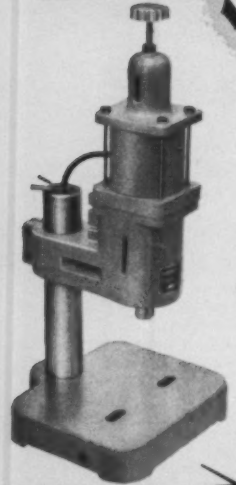

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By Morris A. Mayers, closed circuit TV manager, Visual Electronics Corp., and Rodney D. Chipp, manager of systems engineering, Federal Telecommunications Laboratories; 250 pages, 8¼ by 10¾ inches, illustrated, clothbound, published by John F. Rider Publisher Inc., New York; available from AUTOMATION; *10.00 postpaid.*

Applications of closed circuit TV described and illustrated in the first part of this book include industrial, commercial, and educational uses. The second part of the book presents a simplified explanation of how closed circuit TV works, and the final part of the book describes commercial equipment for closed circuit TV. Bibliographies list sources of more information, and an appendix indicates typical costs for equipment and services.

Association Publications

AIR PRESSURES FOR PNEUMATIC CONTROLLERS AND TRANSMISSION SYSTEMS

Looseleaf, 3 pages, 8½ by 11 inches; available from Scientific Apparatus Makers Association, 522 Fifth Ave., New York 36, N. Y.; Free.

SAMA Standard RC2-1-1958 became an industry standard January 16, 1958. Purpose of this standard is to establish operating pressure ranges and air supply pressures for pneumatic controllers and pneumatic intelligence transmission systems.

PROCEEDINGS OF THE EIA SYMPOSIUM ON NUMERICAL CONTROL SYSTEMS FOR MACHINE TOOLS

Paperbound, 106 pages, 8½ by 11 inches, illustrated; available from Engineering Publishers, Div., AC Book Co. Inc., G.P.O. Box 1151, New York 1, N. Y.; $5.00.

Texts and illustrations are recorded for papers presented at the symposium held September, 1957, and sponsored by Electronics Industries Association. Preparation of data and operation of several commercial numerical control systems for machine tools are discussed in detail by representatives from machine tool builders and control system suppliers.

PROCEEDINGS OF THE 1957 DESIGN ENGINEERING CONFERENCE

Paperbound, 110 pages, 8½ by 11 inches, illustrated; available from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; $4.00.

Publication includes papers sponsored by the ASME Machine Design Division and presented in May, 1957. Among the topics discussed were motor selection; static switching; designing for easier machining, handling, and assembly; hopper feeding; numerical control; and designing machine tools for automatic controls.

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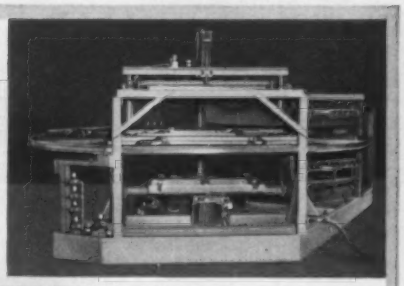

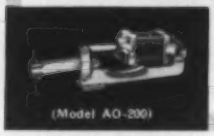

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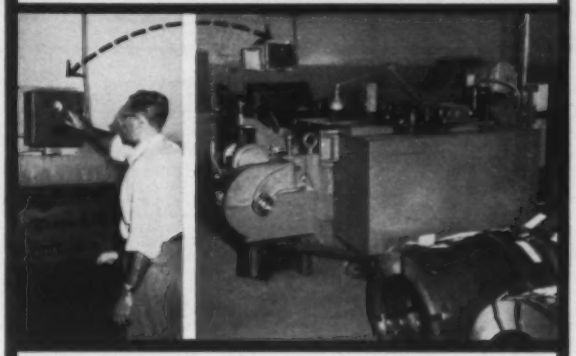

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problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

Case 1522-P
Press Feeding

. . . We are investigating the possibilities of automatically or semiautomatically feeding parts into punch presses. In various divisions we have many types of parts (not strip) being fed by hand into punch presses for additional operations. We wish to reduce both costs and hazards in this area. Any assistance will be very greatly appreciated. . .

Manager, Design Engineering Section

• • •

Case 1528-P
Closed Circuit TV

. . . I would appreciate any information on the use of closed circuit television between plants about eight miles apart. The problem is visual as well as verbal communication between a development engineering group and a model shop which also serves the plant in which it is located. Any suggestions as to sources of equipment and experience with operating over public wires would be appreciated. . .

Vice President

• • •

Case 1543-P
Tube Cutting

. . . We are looking for a simple and compact way of doing the following operation. Labeled tubes are to be run through a multiple saw recutting machine which must cut them to register. The labels are not always exactly the same distance from the end of the tube. This means that we must pick up with a beam on the end of the label, rather than the end of the tube. We would like to purchase a complete system from one manufacturer which would sense the end of the label and actuate a moving part, bringing the label into register with the recutting saws. We would appreciate any information which might help us with this problem. . .

Chief Engineer

Suggestions for 1471-P (April 1958)
Crane Weighing

. . . Just a few lines to inform you that the A. H. Emery Co. of New Canaan, Conn., manufactures scales of the type you require. . .

E. G. Morris
Wallingford Steel Co.

♦

. . . We are enclosing two copies each of Forms 2904-1, 2980, and 2970A, which give a general description of our Model 9936 Electronic Load Cell Crane Scale. We would be glad to send one of our local salesmen to explain more in detail the Model 9936 Crane Scale and answer any questions the reader might have. . .

C. F. Lockert
Toledo Scale Co.

♦

. . . We are definitely interested in helping your reader and would appreciate very much your forwarding the inquiry to this office. We can then best determine which of our branch houses can serve him most readily. . .

C. F. Doepke
Fairbanks, Morse & Co.

♦ ♦ ♦

Suggestions for 1427-P (Apr. 1958)
Linear Speed Indicator

. . . We would be very much interested in working with your reader to solve his problem. There are certain details we must know about his application such as size of rack teeth, resolution desired, and any space limitations that may exist. . .

Lloyd A. Thacher
Electro Products Laboratories Inc.

♦

. . . We believe we can be of some assistance to your inquirer and would be glad to discuss their requirement as outlined. . .

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Farrand Controls Inc.

♦

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G. A. Hotham
Optron Corp.

♦

. . . Perhaps the "Senior Electrical Engineer" would be interested in a method using a radioisotope tagging, in conjunction with one of our rate meters or scalers. We will be glad to investigate his problem if he cares to forward the details. . .

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Radiation Counter Laboratories Inc.

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Circle 484 on Page 127

Liquid Pressure/Level Control

Automatic Control Co., St. Paul 4, Minn.—64 page catalog—Catalog BG-158-30M is a guide to the selection of the proper controls for automatically controlling liquids at predetermined levels or pressures. Systems include telemetering. Functions and applications of the units in the systems are explained. Numerous systems which are described are illustrated by photos and sketches. Wiring diagrams are also included. Price list and ordering information is given.

Circle 485 on Page 127

Bag Packers

H. L. Stoker Co., 111 S. College Ave., Claremont, Calif.—10 sheet fact-file—Data on packers for filling valve and open mouth bags and drums are given. Also described are two packaging systems: The Micro-Metric feeder system which provides accuracy in weight, within one ounce on 50 lb containers, and the Stoker Settler system—a method which settles material in the bag while maintaining weighing accuracy.

Circle 486 on Page 127

Special Machines

American Special Machine Co., 1401 Webster Ave., Chicago 14, Ill.—8 page bulletin—Equipment for plasterboard packaging, carbon cartoning, printed circuits, valve subassembly, terminal pin inspection, valves, etc., is described and illustrated. Production rates are listed.

Circle 487 on Page 127

Digital Voltmeter

Kin Tel, Div., Cohu Electronics Inc., 5725 Kearny Villa Rd., San Diego 11, Calif. — 4 page pamphlet—Digital voltmeter, Model 401 DC, is described in Bulletin 19-2. Also covered are digital accessories, which can be added to permit the measurement of ac, ohms, ratios, to allow scanning multiple inputs, or to drive typewriter and punched tape units. Diagram shows how this can be accomplished.

Circle 488 on Page 127

Metal-Cutting Machines

Snyder Tool & Engineering Co., 3400 E. Lafayette Ave., Detroit 7, Mich.—20 page booklet—Automatic machine tools for low, medium, and high-production operations are described. Production parts, operations, and rate schedules are outlined by generic types of machines. Also explained and illustrated are the "building-block" principle, in-process gaging, and orientation of parts in transfer.

Circle 489 on Page 127

Hydro-Pneumatic Accumulators

Products Div., Greer Hydraulics Inc., New York International Airport, Jamaica 30, N. Y.—6 page pamphlet—Hydro-pneumatic bladder-type accumulators, suitable for use on materials handling and industrial equipment, are described in Bulletin PR-200. Selection data are given for hydraulic circuits requiring pressure storage, primary power reduction, emergency power, pressure-volume compensation, shock absorption, leakage compensation, transfer barriers, and fluid dispensing. Illustrations of the 3000 psi line and 6000 psi line are included.

Circle 490 on Page 127

Remote Control System

Grand Rapids Div., Lear Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.—4 page pamphlet—Remote control system for valves, machine tools, material handling, packaging, and testing is outlined. Functional diagram of the system, which includes a controller-amplifier and a servo drive, is given. Also included is a typical installation drawing.

Circle 491 on Page 127

Flow Meter Accessories

Builders-Providence Inc., Div., B-I-F Industries Inc., 345 Harris Ave., Providence 1, R. I.—8 page bulletin—Instruments and accessory devices, used for changing a standard flow meter from a totalizing unit to one suitable for any combination of remote totalizing, indicating, and recording functions, are outlined in Bulletin 380-L3A. Applications, accuracies, line drawings and capacity charts are given.

Circle 492 on Page 127

Electro Clutches

Transformer & Rectifier Div., I-T-E Circuit Breaker Co., 19th & Hamilton Streets, Philadelphia 30, Pa.—20 page booklet—Electrically operated clutches which provide instantaneous pushbutton or automatic programming control of machine tools, drives, transmissions, and other shaft-driven machinery are described in Bulletin 6304-1A. Applications such as the control of feeds and speeds on lathes, boring mills, and milling machines are discussed. Accessories and accessory parts are also covered.

Circle 493 on Page 127

Continuous Titrator

Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.—4 page pamphlet—Control of chemical concentrations in process slurries by continuous titration is subject of Data Sheet A-58-2. The problem is stated and solution given. Dow-Hart equipment used in the solution is explained. A schematic diagram of the operation is given.

Circle 494 on Page 127

Press Room Equipment

Cooper Weymouth Inc., 600 Honeyspot Rd., Stratford, Conn.—16 page booklet—Slide feeds, wire straighteners, small parts straighteners, combination cradles and straighteners, and scrap choppers are among units described and illustrated in Catalog 58. Construction features, specifications, and prices are noted. Drawings display different applications.

Circle 495 on Page 127

Automatic Vacuum Lifts

Union Tool Corp., Warsaw, Ind.—6 page pamphlet—One, two, four, and six station vacuum lifts and combination vacuum lifts and stackers are described. Uses of these machines for applications involving lifting, moving, and stacking of flat material such as panels, sheets, and blanks are explained. Illustrative examples of units operating in conjunction with conveyor systems are included.

Circle 496 on Page 127

Heat Treating Equipment

Lindberg Engineering Co., 2444 W. Hubbard St., Chicago 12, Ill.—22 pages—Hardening, carbonitriding, and carburizing furnaces of batch and continuous type operations are described in Bulletin 242. The vertical radiant tube, which is the heat source for the furnace, and corrtherm, the element which permits electricity to be used, are explained. Schematic dia-

new catalogs..... latest literature

grams show typical layouts of straight-through and in-and-out-types of furnaces.

Circle 497 on Page 127

Material Handling Equipment

Conveyor Systems Inc., 6451 Main St., Morton Grove, Ill.—72 page handbook—Catalog 6 is an illustrative booklet showing trolley, roller, slat, chain, belt, and special conveyors. Material handling equipment such as portable stacking racks, material bins, and portable shop trucks are also displayed. Charts listing dimensions for attachments are given, and diagrams show different conveyor systems.

Circle 498 on Page 127

Layout Tapes

Labelon Tape Co. Inc., 450 Atlantic Ave., Rochester 9, N. Y.—12 page booklet—Line of layout tapes used for industrial charts and plans is illustrated, with sizes and prices listed. Booklet also outlines the procedure for making a plant layout, discusses the steps from the rough draft to the completed plan. Charting materials and accessories are also noted.

Circle 499 on Page 127

Heating Units

Hotwatt Inc., 16 Gould St., Danvers, Mass.—12 page booklet—Line of precision cartridge heating units and ceramic heating units, in a range of sizes from ¼-inch diameter and up, is described. Diagrams show the construction of the terminal and lead. Ordering instructions are given, and temperature conversion charts listed.

Circle 500 on Page 127

Data Processing System

Systems Div., Beckman Instruments Inc., 325 N. Muller Ave., Anaheim, Calif.—4 page pamphlet—Information on Model 123, data processing system, is contained in Bulletin 3014. The 100 channel data logger, which is suitable wherever variables such as temperatures, pressures, and flows are to be recorded, is described and illustrated with specifications listed.

Circle 501 on Page 127

Flash-Butt Welding

Taylor-Winfield Corp., Warren, Ohio—16 page booklet—Flash-butt welding process is outlined in Bulletin 7-913. Machines designed for special applications such as automotive parts, and small electronic assemblies are illustrated and described. Clamping, flash and upset mechanisms are also displayed.

Circle 502 on Page 127

Miniature Thermocouples

Thermo Electric Co. Inc., Saddle Brook, N. J.—28 page catalog—Line of miniature thermocouples is described. The thermocouples consist of four basic designs—gasket, bayonet, protected, and shielded. The gasket is for surface temperature measurements; bayonet for applications requiring an embedded measuring junction with spring-loaded contact; protected for measuring liquid or gases, and shielded for measuring temperatures of moving gases. Ordering and installation instructions are noted.

Circle 503 on Page 127

Package Drive Units

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.—8 page bulletin—Line of package drive units from 5 to 200 hp is covered in Bulletin 51 B 8166A. Components in the unit are described and illustrated, and the operation explained. Various application photos are given.

Circle 504 on Page 127

Electronic Feed Control

Load Star Corp., 1474 S. Vandeventer Ave., St. Louis 10, Mo.—4 page pamphlet—Instrument is used on motor-driven processing machines, keeps the flow of solids or liquids at a constant and stable maximum capacity. Other applications on equipment such as furnaces and arc welders are given. Installation and operation are explained. An external schematic wiring diagram is included.

Circle 505 on Page 127

Tube Cutters

Steel Products Engineering Co., Div., Kelsey-Hayes Co., Springfield, Ohio—6 page pamphlet—Brehm tube cutters are described which cut any length tube from ¼-inch on up, in diameters from ⅜-inch to 2¼ inches. Other methods and this method of cutting are compared. A schematic drawing helps explain operation and cutting action.

Circle 506 on Page 127

High Vacuum Vapor Pumps

Rochester Div., Consolidated Electrodynamics Corp., Rochester 3, N. Y.—68 page handbook—Data on metal oil, metal mercury, glass oil, and glass mercury pumps are contained in Bulletin 6-1. Charts display performance characteristics for numerous types of pumps. Special pumps and pumping systems are explained and illustrated; and suggestions for selecting the proper pump are given. One section covers pump supplies and accessories.

Circle 507 on Page 127

Adjustable-Voltage Control

General Electric Co., Schenectady 5, N. Y.—4 page pamphlet—Adjustable-voltage auxiliary control systems, suitable for metal rolling and processing industries, are outlined in Bulletin GEA-6711A. Functions of the units are described and diagrams show the basic types.

Circle 508 on Page 127

Air Separation

Superior Air Products Co., 132 Malvern St., Newark 5, N. J.—16 page booklet—Equipment for separating oxygen, nitrogen, and argon from air is described. The various types of air separation plants available are discussed and charts listing descriptive data are given. Drawings display different arrangements of the equipment, and a flow diagram for a converter unit is also included.

Circle 509 on Page 127

Ultrasonic Cleaning

Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn. — 24 page booklet—The application of ultrasonic cleaning in the automotive, metalworking, and electrical fields is discussed in Bulletin S-200. Batch immersion, conveyor, and multistage systems, and transducer arrangements are explained. Also included are data on solutions and chemicals recommended for ultrasonic cleaning.

Circle 510 on Page 127

Work Driver

Seneca Falls Machine Co., 13 Fyfe Bldg., Seneca Falls, N. Y.—12 page booklet—An automatic work driver which can be used on an engine lathe, multiple tool lathe, or universal grinder is described in Bulletin D-57. Diagrams for adapter plate and direct mounting types are given. Ordering instructions are also given.

Circle 511 on Page 127

Pilot Lights

Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.—16 page booklet—Line of pilot lights which includes subminiature indicator lights, edge lighting assemblies, light shields, and dimmers is described in Bulletin L-161. Data for mounting hardware, insulation, type of lens holders, and lenses and colors are given. For some models, circuit diagrams are given.

Circle 512 on Page 127

Automatic Consistency Control

Fischer & Porter Co., 494 Jacksonville Rd., Hatboro, Pa.—4 page pamphlet—Plastometer, a device for continuous automatic control of the consistency of fibrous or pulpy slurries, is the subject of catalog. Operating principle is explained, and charts show different functions and results.

Circle 513 on Page 127

Chain Conveyor

Island Equipment Corp., P. O. Box 276, Miami 38, Fla.—6 page pamphlet—Data on chain conveyor, which is suit-

able for handling cases, boxes, cartons, and cans, are contained in Bulletin DF-3. Three types of chain links are described, and specifications given. Sketches of floor plans show the different types of conveyor systems. Also included are illustrative examples of various applications.

Circle 514 on Page 127

Brake Systems

Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.—4 page pamphlet—Brake systems for bridge drives of overhead traveling cranes, coke pushers, door machines, bending machines, and other mobile and rotating machinery are outlined. Function and construction of the various types are explained. Notes on special systems are given, which include data on the components.

Circle 515 on Page 127

Air Control Valves

Airmatic Valve Inc., 7317 Associate Ave., Cleveland 9, Ohio—60 page catalog—Data on line of valves for mechanical and electrical control in automatic machines are given. Installation diagrams, parts lists, and schematic drawings showing mounting dimensions are noted. Also included are cylinder descriptions and charts listing approximate forces that can be obtained from air and hydraulic cylinders.

Circle 516 on Page 127

Automatic Lathe

Gisholt Machine Co., 1245 E. Washington Ave., Madison 10, Wis.—20 page booklet—Automatic lathe with large horizontal table for tool carrying slides is described in Bulletin 1159-C. Components in the Simplimatic "building-block" type machine are explained and illustrations show the accessories. Numerous other illustrations display different applications.

Circle 517 on Page 127

Pneumatic Conveyor Systems

Fuller Co., Catasauqua, Pa.—16 page booklet—Pneumatic conveying systems designed for handling dry bulk materials is the subject of Bulletin FK-26A. Illustrations show the various stages of operation such as hopper-car unloading stations, portable, stationary, and sanitary pumps, and loading bulk tanks. Drawings display different applications of conveying systems.

Circle 518 on Page 127

Stationary Compressors

Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa.—8 page bulletin—Heavy-duty high pressure stationary compressors for soot blowing, chemical processing, and gas compression are covered in Bulletin A-93. Four basic models, which range in capacity from 368 to 2000 cfm, are described. Components in the machine are illustrated, their construction and function explained.

Circle 519 on Page 127

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Press Room Equipment

U. S. Tool Co. Inc., Ampere (East Orange) N. J.—21 page booklet—Slide feeds, roll feeds, air-operated feeds, stock straighteners, stock reels, coil cradles, combination cradles and straighteners are described and illustrated in Bulletin 85. Construction features are noted and method of operation explained. Charts list sizes and specifications.

Circle 520 on Page 127

Enclosed Pancake Motors

Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis.—4 page pamphlet—Flange type motors, suitable for use in limited space, are described in Bulletin 2100. Photos of the fan-cooled motor rated at 5 hp, 1800 rpm, and the non-ventilated motor rated at 1 hp, 1800 rpm, are shown. A cutaway drawing shows how the motors achieve their short length through formed end coils and a one piece housing-bearing bracket.

Circle 521 on Page 127

Receiver Recorder & Controller

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—16 page booklet—Data are given in Bulletin E12-5 on receiver recorders and controllers, which are suitable for pneumatic and electric transmission and mechanical measuring systems. Plug-in components are described and the one-year inking system is explained. Diagrams show typical measuring circuits.

Circle 522 on Page 127

Lubricating Devices/Shaft Seals

Gits Bros. Mfg. Co., 1850 S. Kilbourn Ave., Chicago 23, Ill.—28 page catalog—Data on line of lubricating devices and shaft seals such as oil cups, constant level oilers, vibrating rod oilers, oil gages, and grease cups, are contained in Catalog 65. Construction material is noted and specifications given. Also included is information on accessories.

Circle 523 on Page 127

Magnetic Clutches & Brakes

Fawick Airflex Div., Fawick Corp., 9919 Clinton Rd., Cleveland 11, Ohio—8 page bulletin—Magnetic clutches, with diameters from 2 inches to 13 inches and torque ratings from 27 to 66,000 in.-lb, are discussed in Bulletin M-101-A. Data, including dimensions, power requirements, and heat dissipation characteristics, are given. Cutaway drawings show how the clutch works.

Circle 524 on Page 127

Speed Control

Acme Electric Corp., Cuba, N. Y.—4 page pamphlet—A stepless speed control, which converts alternating current for direct current motor drive, is the subject of Bulletin R-313. Data on selecting the proper dc motor for different applications are given. How the unit uses ac power to provide the infinite speed control of dc motor drive is explained. Notes on the circuit are included, along with diagrams.

Circle 525 on Page 127

Transducer Definitions

Instrument Sales Div., Bourns Laboratories Inc., P.O. Box 2112, Riverside, Calif.—2 page pamphlet—Technical terms used in potentiometer transducer instruments are contained in Bulletin IDEF/B/8. Approximately 42 words, under headings such as environmental, calibration, test conditions, linearity, and over-range, are defined. Definitions are based on the National Aircraft Standard Committee Specification NAS 710.

Circle 526 on Page 127

Insulated Wire and Cable

American Super-Temperature Wires Inc., Winooski, Vt.—4 page pamphlet—Facilities and processes for producing high temperature insulations on magnet wire, coaxial cable, hook-up wire, lead wire, and lacing cord are described. Procedures in the magnet wire department, processing department, testing laboratory, and extrusion department are noted.

Circle 527 on Page 127

Hydraulic Cylinders

Sheffer Corp., 326 W. Wyoming Ave., Cincinnati 15, Ohio—2 bulletins—Hydraulic cylinders with 1⅛ to 12-inch bore size, rated at 2000-3000 psi, are described in Bulletin 658. Data on 14 standard mountings and 4 rod end styles are given. Bulletin 558 covers line of interchangeable air and low pressure hydraulic cylinders in 12 bore sizes from 1⅛-inch to 14 inches. Numerous drawings show the different styles.

Circle 528 on Page 127

Steel Belt Conveyors

Prab Conveyors Inc., 30121 Groesbeck Hwy., Roseville, Mich.—9 page bulletin—Brochure SB-70 shows applicational photos of piano hinge steel belt conveyors, suitable in the handling of press scrap, turnings, steel parts, and chips. Design can be adapted with special flights and discharge mechanism for use as a parts feeder. Drawings show different conveyor layouts.

Circle 529 on Page 127

Tracer-Controlled Milling Units

Colonial-Romulus Div., Colonial Broach & Machine Co., Parkgrove Station, Detroit 5, Mich.—6 page pamphlet—Line of tracer-controlled milling units which can be mounted, fixtured, and operated in any plane is described in Bulletin CRD-58. Application photos show the various setups of the equipment that can be used in a wide range of metals. Also discussed and illustrated is the Hydro-Cycle contour mill, designed for heavier applications.

Circle 530 on Page 127

Vari-Speed Motor Pulleys

Reeves Pulley Div., Reliance Electric & Engineering Co., 1225 Seventh St., Columbus, Ind.—20 page booklet—Units designed for applications from ½ through 15 hp, with up to 4 to 1 ratios of speed variation, are covered in Bulletin V-582. Charts list their output speeds, belt pitch length, and shaft center distance. Also given are data on precision adjustable position motor bases.

Circle 531 on Page 127

Woodworking Machinery

Greenlee Bros. & Co., 2136 Twelfth St., Rockford, Ill.—20 page booklet—Woodworking machines, including finger-jointing machines, hydraulic feed gang borers, roll-feed rip saws, dovetailers, cut-off saws, and dowel borers, are described and illustrated in Catalog W-504. Company's facilities for designing and manufacturing machines are described.

Circle 532 on Page 127

Dry Type Transformers

Hevi-Duty Electric Co., 2040 W. Wisconsin Ave., Milwaukee 1, Wis.—8 page bulletin—Three phase, dry type power and lighting transformers, with output ranges from 6 to 2000 kva, are described in Bulletin 200. Capacities, dimensions, sound levels, weights, prices, and wiring diagrams are noted.

Circle 533 on Page 127

Flow Meter

Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Avenues, Philadelphia 44, Pa.—20 page booklet—Two basic models are discussed in Catalog C22-1—one for flow and liquid level in open tanks, the other for liquid level in closed tanks under pressure or vacuum. The operation and construction is explained. Case instruments are described and illustrated. Also given are data on miniature instruments for remote operation.

Circle 534 on Page 127

Motors/Generators

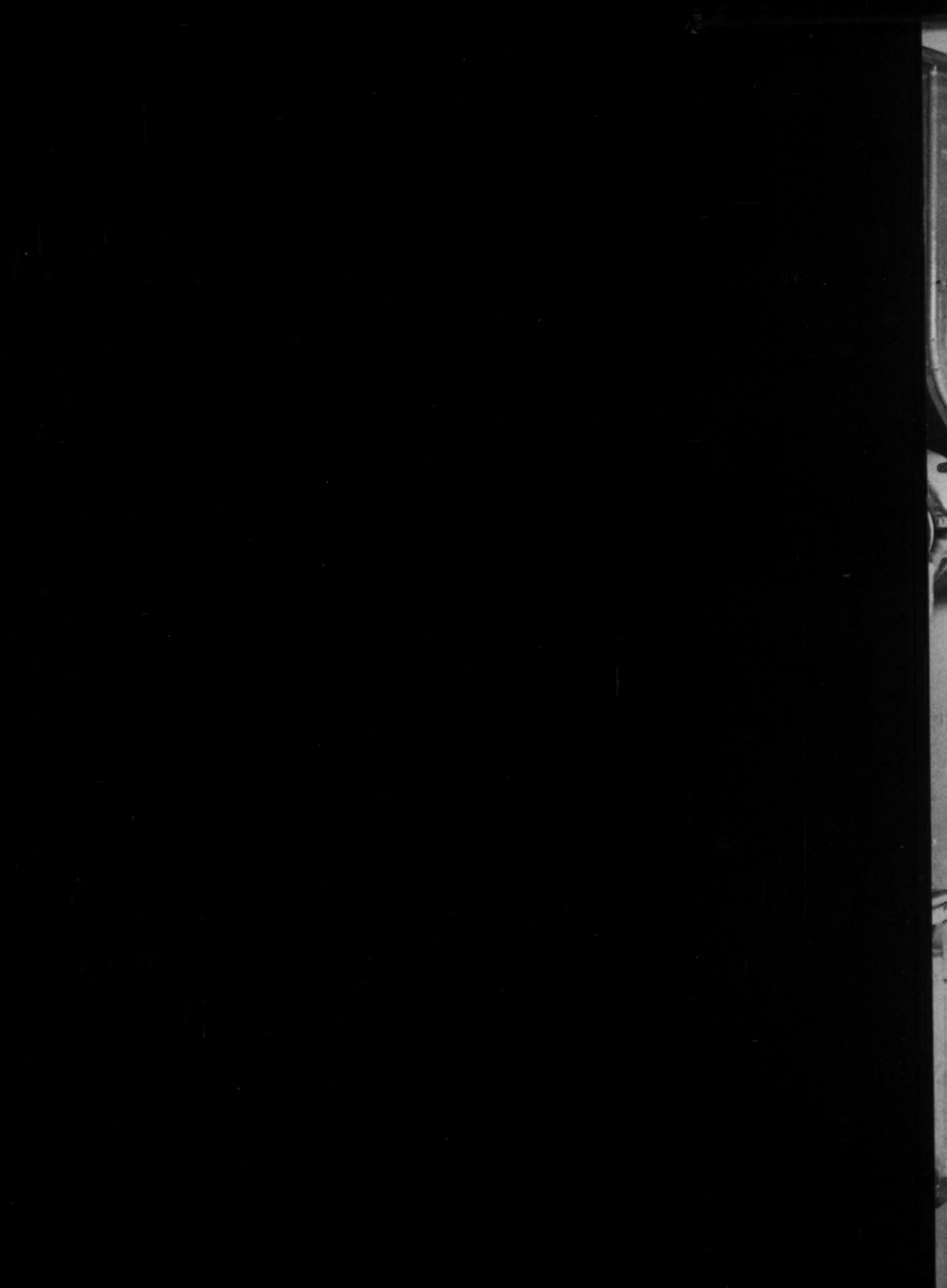
Century Electric Co., 18th & Pine Sts., St. Louis 3, Mo.—12 page booklet—Line of polyphase, single phase, and direct current motors, from 1/20 to 400 hp, is described in Bulletin 270. An application chart lists data on typical driven equipment, character of loads, and starting and running torques. Also included are notes on selecting the proper motor for the required operation.

Circle 535 on Page 127

Air Operated Pumps

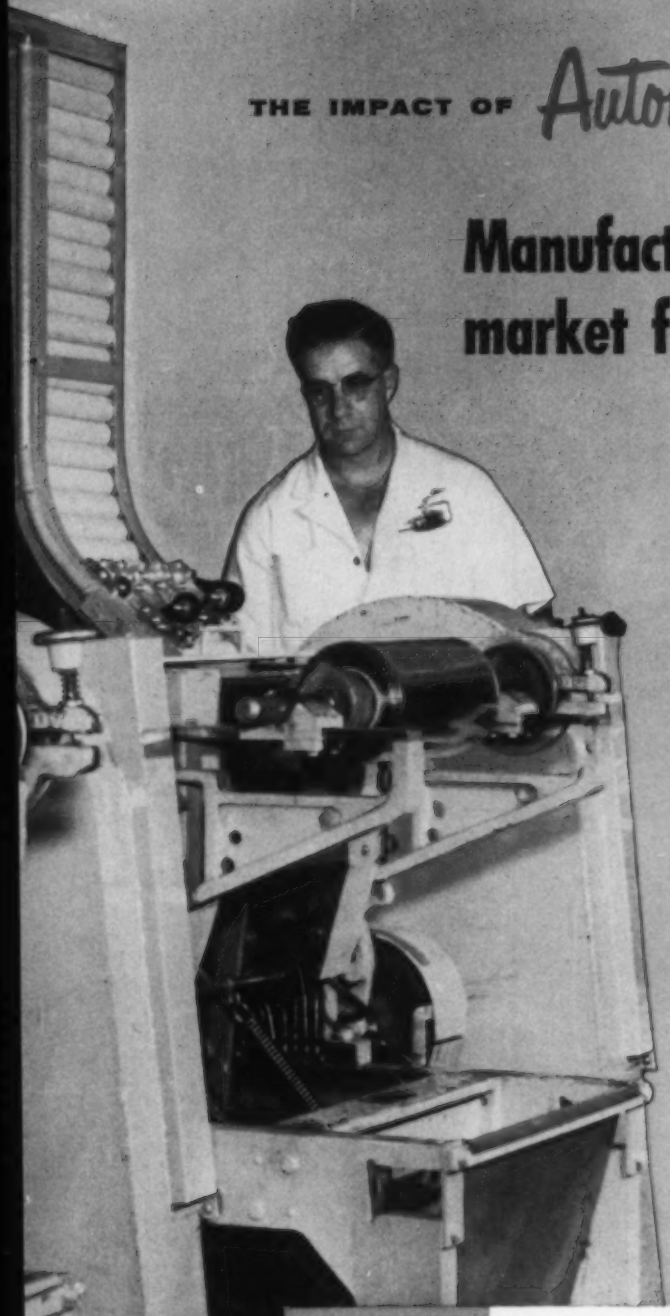
Lincoln Engineering Co., 5794 Natural Bridge Ave., St. Louis 20, Mo.—32 page catalog—Line of air-motor operated lubricant pumps, which can handle all materials from light oils to heavy fibrous greases and viscous coatings, is described in Catalog 65. Lubricant-output-performance and selection charts are given. Accessories for the pumps are also discussed and illustrated.

Circle 536 on Page 127



THE IMPACT OF *Automation* ON TODAY'S BUSINESS

Manufacturer builds million dollar market from last night's leftovers



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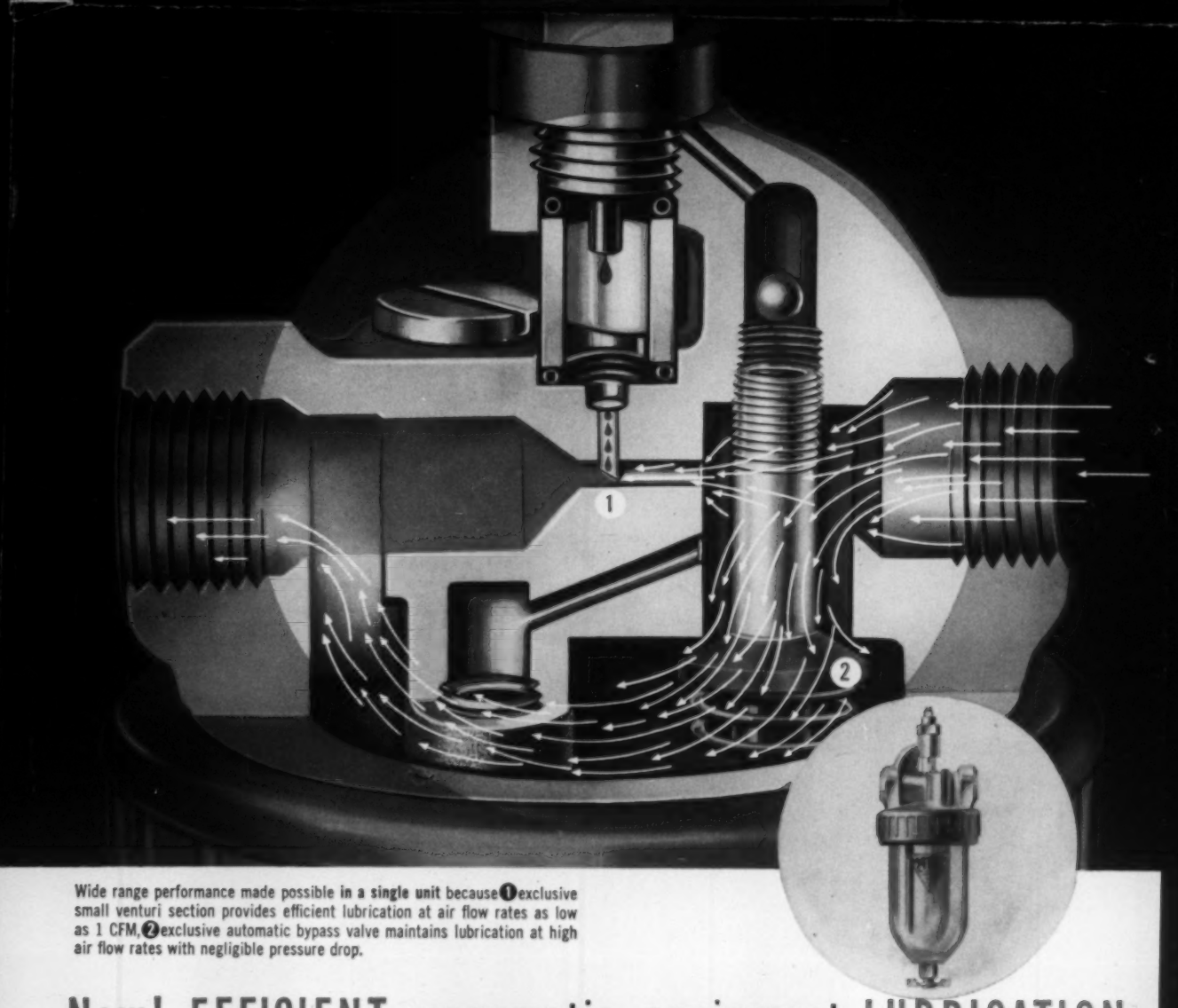
Circle 652 on Page 127



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